EDISON ELECTRIC INSTITUTE BULLETIN

MARCH, 1939

The Electric Utility Exhibits at the New York World's Fair 81

Notes on the E.E.I. Convention 81

Controlling Factors Affecting Use of Residential Electric Energy . . . . . SHERMAN M. HALL 87

"Old Ice Box Round-Up" Is Launched 95

Recent Developments in Cable Fault Locating . . . . JAMES A. VAHEY 96

Design of Substations for Accident Prevention . . DR. MORRIS S. VITELES 101

Property-Life Insurance . . . . . BERNARD S. RODEY, JR. 107

Edison Medal Now Available to Employees of All Companies 108

"A Letter to Charlie": in re Power . . . . . JOHN H. CAMPBELL 109

Electrical Features in the Modernization of the Louisiana Steam Generating Station . . . . . H. B. WOOD 111

Operation of AC Low Voltage Network from Two Voltage Sources . . . . . W. B. KENYON 115

The Pole Top Method of Resuscitating Linemen After Electric Shock . . . . . E. W. OESTERREICH 119

Why Purchase Electric Power from a Public Utility? . JOHN HOWELL, JR. 122

Recent Publications of the Institute 125

Notes on Coming Meetings 127

Convention and Meetings, 128

EDISON ELECTRIC INSTITUTE

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF DECEMBER

	1938	1937	%
	SOURCE OF ENERGY		
Kilowatthours Generated (Net)			
By Fuel Burning Plants	6,691,295,000	6,182,601,000	+ 8.2
By Water Power	3,554,675,000	3,317,033,000	+ 7.2
Total Generation	10,245,970,000	9,499,634,000	+ 7.9
Net Purchases			
From Other Sources	360,882,000	327,085,000	+10.3
Net International Imports	109,157,000	105,783,000	+ 3.2
Total Purchased Power (Net)	470,039,000	432,868,000	+ 8.6
Total Input	**10,716,009,000**	**9,932,502,000**	+ 7.9
	DISPOSAL OF ENERGY		
Total Sales	**8,779,316,000**	**8,049,162,000**	(a)
Energy Not Reported as Sold			
Used in Electric Railway Department	38,062,000	61,171,000	(a)
Used in Electric and Other Departments	150,954,000	151,749,000	(a)
Furnished Free or Exchanged in Kind	2,367,000	(Not Shown)	(a)
Total Not Reported as Sold	191,383,000	212,920,000	(a)
Total Energy Accounted For	**8,970,699,000**	**8,262,082,000**	+ 8.6
Losses and Energy Unaccounted For	1,745,310,000	1,670,420,000	+ 4.5
Total Output (To Check Above "Input")	**10,716,009,000**	**9,932,502,000**	+ 7.9

CLASSIFICATION OF KILLOWATTHOUR SALES

Based on FPC Classification—December 1938		**Based on EEI Classification—December 1937**	
Residential or Domestic	1,842,852,000	Domestic	1,706,862,000
Rural	(Allocated to Other Classes)	Commercial—Small Light and Power	1,591,729,000
Commercial and Industrial	5,939,898,000	Commercial—Large Light and Power	3,866,515,000
Public Street and Highway Lighting	206,398,000	Municipal Street Lighting	243,400,000
Other Public Authorities	205,294,000	Street and Interurban Railways	421,993,000
Sales to Railroad and Railways	547,248,000	Electric Steam Railroads	118,117,000
Interdepartmental	27,297,000	Municipal and Miscellaneous	100,546,000
Other Sales	10,329,000		
Total Sales	8,779,316,000	Sales to Ultimate Customers	8,049,162,000

CLASSIFICATION OF CUSTOMERS

Based on FPC Classification—December 31, 1938		**Based on EEI Classification—December 31, 1937**	
Residential or Domestic	23,211,313	Domestic	22,620,117
Rural	(Allocated to Other Classes)	Commercial—Small Light and Power	3,891,584
Commercial and Industrial	4,602,939	Commercial—Large Light and Power	578,581
Public Street and Highway Lighting	26,407	Municipal Street Lighting	35,687
Other Public Authorities	76,905	Street and Interurban Railways	262
Railroad and Railways	276	Electric Steam Railroads	27
Interdepartmental	280	Municipal and Miscellaneous	37,729
Others	3,573		
Total Customers	27,921,693	Total Ultimate Customers	27,163,987

REVENUE (b)

Based on FPC Classification—December 1938		**Based on EEI Classification—December 1937**	
Revenue from Sales (Excluding Sales to Other Electric Utilities)	$197,111,200	Revenue from Ultimate Customers	$189,276,500
Other Revenue	1,879,500		
Total Revenue	$198,990,700		

ESTIMATED DOMESTIC ELECTRIC SERVICE RATIOS

(For the 12 Months Ended December 31st)

	1938	1937	%
Kilowatthours per Customer	853	802	+ 6.4
Average Annual Bill	$36.08	$35.29	+ 2.2
Revenue per Kilowatthour	4.23¢	4.40¢	− 3.9

(a) Data for two years not strictly comparable.
(b) Data not comparable because of an unascertainable amount of "Revenue" in December 1938, which may or may not have been included in the 1937 data.

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 7 MARCH, 1939 No. 3

The Electric Utility Exhibits at the New York World's Fair

Forward March of America, and The Electrified Farm

THE story of electricity will be magnificently told at the New York World's Fair: its history; its present use; its even greater future services to man.

Ten of the principal buildings at the Fair have been constructed to show one phase or another of electricity's place in the World of Yesterday, Today and Tomorrow. Many other buildings will supplement the main exhibits in demonstrating its uses. Every structure in the grounds, every inch in the Fair's 1216 acres, will function more smoothly through its beneficence.

These are the exhibits to be devoted to electricity and its manifold uses in the Modern World:

Forward March of America

The Electrified Farm

The Consolidated Edison Company Exhibit (which will also include gas)

The General Electric Exhibit

The Westinghouse Electric & Manufacturing Company Exhibit

The Electrical Products Building (various manufacturers)

Carrier Corporation Exhibit (Air conditioning)

American Telephone & Telegraph Company Exhibit

Radio Corporation of America Exhibit

Crosley Radio Exhibit

Forward March of America and The Electrified Farm, the two exhibits to be described in this article, are sponsored by the electric utility industry through the Electric Utilities Exhibit Corporation, and financed by some 175 electric companies. Alfred H. Schoellkopf, president, Niagara Hudson Power Corporation, is president of the Exhibit Corporation.

Leading units of the industry are members of the corporation, and its directorate includes Charles W. Kellogg, chairman of Engineers Public Service Company and president of the Edison Electric Institute; Wendell L. Willkie, president of The Commonwealth and Southern Corporation; Edward J. Doyle, president of the Commonwealth Edison Company of Chicago; Harvey C. Couch, president of Arkansas Power &

NOTES ON THE E.E.I. CONVENTION

THE program of the Seventh Annual Convention of the Institute is being arranged so that generous opportunity for visiting the New York World's Fair will be afforded delegates.

The business program will be concentrated in three sessions, to be held on the mornings of June 6, 7 and 8 at the Waldorf-Astoria Hotel, the Convention Headquarters, thus leaving the afternoons and evenings free for attendance at the Fair.

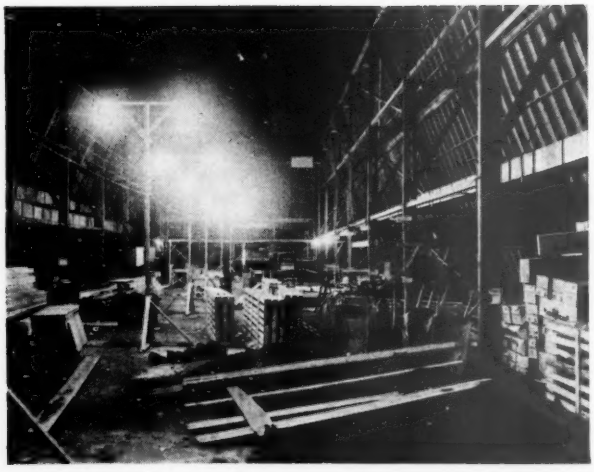
The opening day of the Convention, Tuesday, June 6, has been officially designated by the Fair Authorities as Edison Electric Institute Day. On the afternoon of that day, following the first business session, the Convention will move, *en masse,* by reserved train to the Fair for a special World's Fair Meeting, which will be an introduction of the delegates and public to the electrical exhibits at the Fair. The president of the Fair and leaders of both the production and manufacturing branches of the electrical industry will speak at this meeting. These brief talks will be followed by guided tours of electrical exhibits.

The three morning business sessions, the Tuesday afternoon session at the Fair, and a luncheon meeting Thursday, June 8, at the Waldorf-Astoria will comprise the official Convention activities, although an Operating Committee meeting, and perhaps other committee meetings, will be held on Monday, June 5. A luncheon on Tuesday, June 6, at the Fair is planned for the ladies attending the Convention.

Every effort is being concentrated toward having a strong and forward-looking program of addresses at the business sessions. Among the subjects will be "Keeping Up With Changes in Public Opinion," "The Case for Central Station Power," "Electric Power and the National Defense," "The Achievements of Private Enterprise," "Factors Affecting Price Levels of the Next Five Years," "The Outlook for Real Estate and Building Development," "Progress in Building Rural Load," "Electrical Development in Europe."

Particulars of the program will appear in later issues of the BULLETIN.

The usual circular containing hotel information and reservation blanks will be forwarded to members within the next few days.

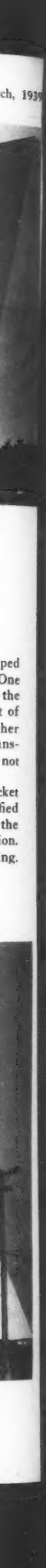


FORWARD MARCH OF AMERICA UNDER CONSTRUCTION

The exhibit is built in the form of a "U" around a landscaped court containing a serpentine pool, flower beds, walks, etc. One arm of the "U" is a long wing with sloping walls housing the Street of Yesterday. The base of the "U" is the central part of the building containing the Avenue of Tomorrow. The other arm of the building houses the Avenue of Tomorrow. The transmission tower, designed to dominate the whole building, is not shown in these photographs.

The top photograph shows the right wing enclosing the Rocket Room and Lounge. The weir for the waterfall may be identified by the portholes which serve as windows for the Lounge. To the left is seen the Avenue of Tomorrow in course of construction.

The bottom picture shows a section of the rear of the building.



Light Company; Colonel Oscar H. Fogg, executive vice-president of the Consolidated Edison Company of New York, Inc.; Louis H. Egan, president of the Union Electric Company of Missouri; Horace P. Liversidge, president and general manager of the Philadelphia Electric Company; Albert B. Paterson, president of the New Orleans Public Service, Inc.; H. Hobart Porter of the American Water Works & Electric Co., Inc.

The Forward March of America exhibit, of which Harrison & Fouilhoux are the architects, is built in the form of a "U" around a lanscaped court containing a serpentine pool, flower beds, hedges, trees and walks. One arm of the U is a long wing with sloping walls housing the Street of Yesterday, the base is a similar structure which contains the Avenue of Tomorrow, while the other arm contains a spectacular "Rocket Room" and a lounge. This exhibit is located in the Production and Distribution zone adjoining the Theme Center.

Important features of Forward March of America are two streets, mentioned above, complete in every detail and contrasting life without electric service in 1892 with the fully electrified world of today and tomorrow. The "Avenue of Tomorrow" will show by dramatic contrast with the cobblestoned, gas-lit thoroughfare the almost unbelievable progress made in less than fifty years; how electricity has contributed to that progress and what electricity means today in the life of the individual, in the community, in the state and in the nation.

Although construction of the 1892 street has been virtually completed, work on other parts of the exhibit is still in progress and several of its most spectacular elements have not yet been installed.

One of these is a 150-foot transmission tower in the court near the main entrance, which leads into the mauve decade part of the exhibit. Another is a forty-foot waterfall which will flow from the top of the righthand arm of the "U" into the serpentine pool.

Another distinctive feature of the forecourt will be a huge copper screen, 30 feet high and 175 feet long, showing the generation of electricity—the digging of coal, the huge turbines and generators in the power plant that transform the coal into electricity, the transmission lines and distribution systems that carry the electricity to homes, offices, stores, factories, mines, farms, mills—everywhere in the country.

The exit from the exhibit will be through a glass tunnel beneath the waterfall, which dashes over the tunnel, so that visitors have the impression of actually walking through the waterfall.

At night the exterior of the exhibit will be breathtaking in its beauty. Mercury vapor and incandescent searchlights and floodlights will bring out the graceful contour of the transmission tower, the blue-white light making a silver tracery of its polished framework. From the platform of the tower near the brilliantly lighted crown, high-intensity mercury vapor searchlights will direct their narrow beams to the waterfall and the pool at its base, lending a cool, greenish white color to the sparkling water. Lighted portholes underneath the waterfall will add to the beauty of the spectacle. The wing walls at each side of the weir, in contrast to the shimmering water, will be a deep blue and the lighting will emphasize the silver white of the glass tunnel emerging from the waterfall.

Concealed mercury spotlights will enhance the beauty of the trees, flowers and hedges; intense floodlighting will bring to life the golden red and copper hues of the symbolic screen showing the generation of electricity; small projector or reflector lamps concealed in the shrubbery will illuminate the facades of the buildings so that all the different shades of blue and bluish white blend into a perfect harmony of color. The main entrance to the exhibit—directly underneath the tower—will be brilliantly lighted with flush lens plates, or so-called "down lights" in addition to light projected downward from the transmission tower.

On entering the building, the visitor will be transported back nearly 50 years to a street of 1892. He will find himself in the lobby of a theatre with posters featuring the melodramas for which the era is noted. Emerging from the lobby the illusion of the nineties will be complete—the Street of Yesterday before him—narrow sidewalks with bluestone flagging; cobblestones, a clanging horse-drawn street car and ice wagon at one end of the street; a maze of telegraph wires overhead; gas lighting, houses and stores huddled together and crowding the sidewalks; old balustrades line the sidewalks, joining the flights of steps to many of the building entrances.

The last word in transportation on the Street of Yesterday.

Passing down the street, visitors will see the typical dimly lit stores of the times, piled high with merchandise—a shop with women's dresses and unmentionables, a watchmaker, a harness and saddle shop, a novelty shop, a photographer's studio, a lighting fixtures store (which up to that time has dealt mainly in gas fixtures and oil lamps) an apothecary, a hair store featuring wigs, bangs and transformations, where a rather daring lady has ventured to have her hair "done" at a shop instead of her own home, and where she can be seen having her hair dried—with a palm leaf fan!

Through the lace curtains of the "parlors" the dimly lit interiors are visible—plush chairs and ornate furniture, the many "dust collectors," the heavy gold framed pictures of "the family" solemnly looking down on the occupants. The wheezy phonograph is squeaking its tunes. Laughter and singing are heard from one of the parlors where a gay party is going on.

The basement kitchens, too, relieve the times. In one kitchen a woman can be seen washing clothes over an old washtub, adding them slowly to the steaming washboiler on the coal stove nearby; in another kitchen a woman is ironing, going back and forth to the stove with the sad-iron as it cools; in another the lady of the house is washing dishes at the kitchen sink while the rest of the family is gathered under a flickering gas light playing checkers; in still another house further down the street, a woman is raising clouds of dust with a broom and elbow grease.

At the end of the street is the office of the electric light company, which will be celebrating the *tenth* anniversary of the electrical industry. One of the windows has a display of incandescent lamp bulbs which the company is offering at the amazingly low price of 80c each, and urging customers to make use of electric lighting in their homes. "Electricity is the light of today and of the future" a

A modern miss buys a paper in the Street of Yesterday which the Electric Utilities Exhibit Corporation has built at the New York World's Fair 1939 to provide contrast for its ultra-modern Avenue of Tomorrow. Below—She pauses beneath a gas street lamp to compare her modern wrist watch with the ornate timepieces of two generations ago. Yes, the street only dates back to 1892, showing the revolutionary changes that electricity and other inventions have wrought in less than fifty years. She then drops by to be photographed in the up-to-the-minute office of the struggling young electric company of the period—an office complete and authentic in every detail, the desk wall flanked with spittoons and plenty of dust on the files. From this office visitors will pass into a modern utility office and finally onto the modern brilliantly lit Avenue of Tomorrow.

placard proclaims. In another display, the company proudly calls attention to the fact that the infant electrical industry now has 40,000 customers and pays $750,000 a year in taxes.

The office itself is a dingy room cluttered with oak furniture; the far left corner is partitioned off as an executive office; the usual black safe, coal stove, high bookkeeper's desk with its clutter of papers are at the left. The lighting here, however, is *electric* lighting, as becomes the electric company office. Prominently displayed on the rear wall of the office is a picture of Thomas A. Edison, with the following quotation:

"The electrical development of America has only well begun. So long as there remains a single task being done by men or women which electricity could do as well, so long will that development be incomplete. What this development will mean in comfort, in leisure, and in opportunity for the larger life of the spirit we have only begun to realize. Great days are ahead . . . and electricity will have a great part to play, granted only that it can be unfettered, with full opportunity for the largest possible individual initiative and energy."

Underneath this is the electric company's pledge:

"YOUR ELECTRIC COMPANY PLEDGES ITSELF TO SERVE THE PROGRESS OF AMERICA BY EXTENDING THE USES OF ELECTRICITY"

Leaving the old company office, visitors will walk through a curved passage from which they can neither see what they just left, nor what lies ahead, and illusion temporarily is suspended. They emerge suddenly into the office of the modern electric company, spacious and brightly lighted. Here the fulfillment of the pledge made in 1892 is dramatical-

ly presented. In a unique and arresting display the contribution of electricity to the FORWARD MARCH OF AMERICA will be seen—electricity in the home, commerce, industry, medicine and surgery, aviation, transportation, motion pictures, television, telephone, telegraph, cable, radio, safety beacons for guidance and protection on land, sea and in the air, etc.—electricity's place in the world of today.

Through the glass windows of the office visitors see stretched before them the Avenue of Tomorrow, ablaze with light, as the merchants cooperate in the celebration of National Power Week. The tops of the buildings on the street are lost in the darkness of the sky. In the distance, however, the city's skyscrapers can be seen, with their myriad lights; automobiles move swiftly along a ramp at the end of the street; the hum and noise of a busy thoroughfare are heard.

The store fronts and buildings are completely modern. Plate glass, frosted glass, carrara structural glass and glass blocks are used extensively both for the stores and upper floors of the buildings.

The windows will be typical of the stores of today—fashions, perfumes, cosmetics, florist, oriental shop, book store, glassware, jewelry, electrical displays, beauty salon, art shop, etc. Each store is mute evidence of the revolution in retail commerce brought about by electricity.

In addition to their regular displays, the windows of the stores in this modern street will feature an electrical industry display, as a tribute by the merchants cooperating in National Power Week.

Leaving the modern street visitors find themselves in the Rocket Room—the climax of the exhibit. Here all the magic of light, color and music are woven into a spectacle of transcending beauty and sound. Spectators will stand on a circular platform that seems to be supended in space; tonges of flame dart out from all sides; soft music can be heard. In the center of the pit appears a glowing, gleaming mass, a symphony of light and color in motion, then out of its midst a whirling mass that seems to have imprisoned within itself all the colors of the spectrum, shoots suddenly skyward where it appears to burst, releasing its colors, which fall like a cascade around the spectators, bathing them in light and color. The musical accompaniment keeps pace with the mood of the entire performance, so that at the climax it, too, seems to burst and mingle with the light and color. The entire spectacle is produced electrically.

From the Rocket Room visitors emerge to a spacious and attractive lounge. The windows in the lounge are the portholes underneath the waterfall, so that a constant cascade of water will be visible. A Personal Service Bureau for the convenience of customers of electric light companies is maintained in the lounge. Passing out of the lounge through a circular tunnel of curved glass, 18 feet in diameter which crosses a moat, the visitors leave the building, through the waterfall, having traversed the entire curve of the "U."

The Electrified Farm

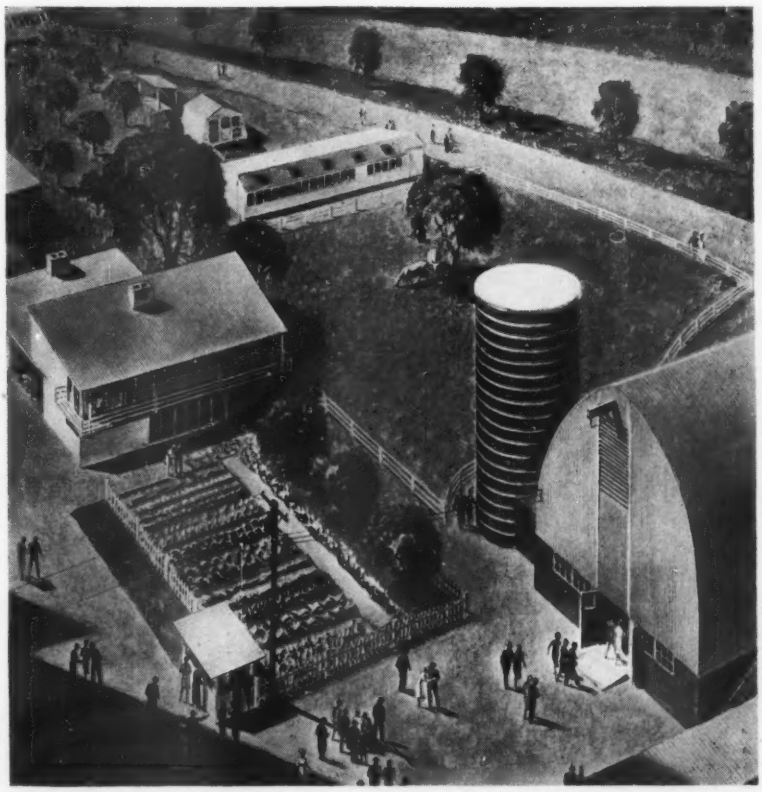
More than one hundred practical applications of electricity on the farm, including some new equipment not yet on the market, will be shown in The Electrified Farm of the electric utility industry at the New York World's Fair.

Visitors will see a practical working farm, with a farm house and buildings, completely equipped, cattle, horses, chickens, every last thing one would expect to find on a farm—all on less than one acre.

The house is an attractive two-story frame structure, with the most modern conveniences. On one side is a flower and vegetable garden; apple trees and elms make a picturesque setting for the house, and maples in the pasture lot provide shade for the cattle. At one end of the plot are the silo and barn, with a bull exerciser at one corner of the barn, the milking parlor, dairy room, workshop and horse shed; at the other end, the poultry house, brooder house, greenhouse, hotbeds, community packing house and orchard.

The cattle—Guernseys, Jerseys, Holsteins and Ayrshires—will be supplied from famous herds by the breeder associations; the horses will be pure-bred Belgian draft horses.

Many of the uses of electricity are well known to the nearly 1,500,000 farms receiving electric service. At The Electrified Farm all of the common uses, and many of the new, tested and proved practices that are within the means of



Artist's sketch of The Electrified Farm of the Electric Utility Industry

the average farmer, are assembled in a complete working unit.

One of the most outstanding recent developments in the farm field, and one that has tremendous future possibilities for the farmer, is refrigerated storage for perishable farm products. At the Electrified Farm there will be shown for the first time a two-compartment refrigerator — one compartment for quick freezing—and an electric freezing cabinet, which may take the place of the present locker storage. The refrigerator, in the all-electric kitchen in the farm house, is divided into two compartments of approximately 12 cu. ft. each. On one side the temperature is held at zero, for freezing and holding meats, poultry and farm products; on the other side the regular refrigerator temperature is maintained. The electric freezing cabinet has about 30 cu. ft. of freezing and storage space, which is the approximate space necessary for an average farm family.

With these cabinets it is possible to freeze, on the farm, fruits, vegetables, meats and poultry, and keep them indefinitely.

The barn is up-to-date in every respect—proper lighting and ventilation, drinking cups, the latest type stalls with rubber covered cow beds, grinding and mixing of feed and pumping of water.

In the milking parlor and dairy room the milking operation and the various steps in the processing, bottling and cooling of milk will be demonstrated.

In the poultry house and brooder house, a complete poultry unit is shown. There will also be an egg cleaner, grader and latest type candler, and waxing equipment to remove feathers in preparing broilers for market.

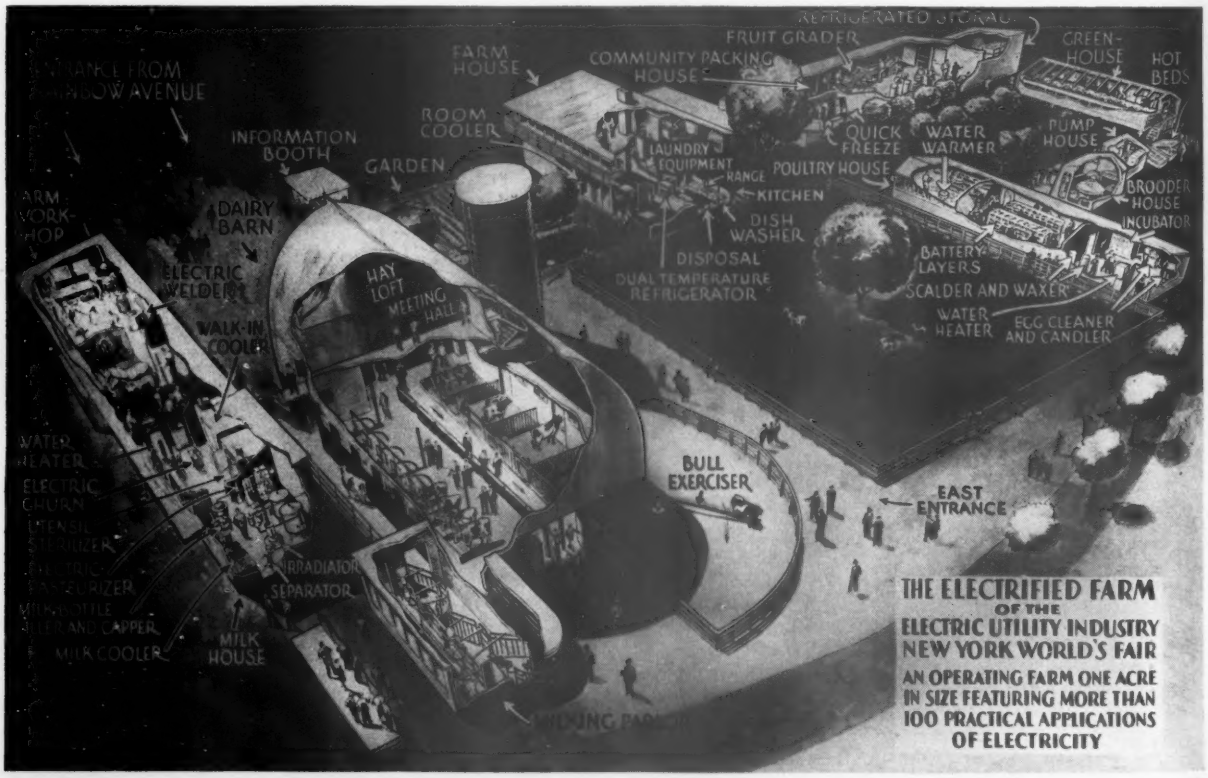
The community packing house demonstrates what groups of farmers, such as Granges, or other farm organizations, can do in a community to handle their own products. A fruit cleaning and grading system will be in operation, also a new type of equipment for cleaning and packing potatoes. There is a cold storage room at one end of the packing house.

The greenhouse is so insulated that a central heating plant is unnecessary, the heat of the electric heating lamps and the sun's rays through the glass of the greenhouse furnishing all the heat necessary. It demonstrates what can be done on the farm by the farmer himself, with a very small outlay. Flowers out of season and an early start for garden plants are made possible with such a greenhouse. Adjacent to the greenhouse are electric hotbeds.

There will be no conducted tours on the Electrified Farm. Visitors can go through any building, ask questions and talk with members of the staff.

Farm electrification in the United States is the result of more than forty years' cooperation by the electric utility industry, the farmer, manufacturers of electrical machinery and equipment, farm organizations, agricultural colleges and others to electrify the farms of the country and make possible better machinery for more economical farm operations. Today, nearly a million and a half electrified farms and more than two hundred practical applications of electricity testify to this work.

The Electrified Farm at the New York World's Fair shows some of the things electricity can do to make farm life more comfortable for the farmer and his family and how it can put money in the pocket of the farmer who avails himself of modern equipment and appliances.



Sketch showing location of various features on The Electrified Farm

Controlling Factors Affecting Use of Residential Electric Energy

The Business Cycle Is Principal Factor—Lowering of Rates Does Not Necessarily Increase Consumption—Greater Use Depends on Appliance Purchases—Appliance Purchases Influenced by Consumer Buying Power, Which Is in Turn Affected by General Business Activity, and First Cost

By Sherman M. Hall

Assistant Manager, Statistical Bureau, Department of Technical Development and Research, Consolidated Edison Company of New York, Inc.

CONSUMPTION of electric energy for domestic use is influenced by many factors, with, surprising as it may seem, the principal factor being the business cycle.

That electric energy use for industrial power should vary with business activity seems quite logical, but that general business should exert an appreciable effect on residential use requires a little consideration. This effect of the business cycle is reflected not only on the total amount of energy consumed, but upon the components of the total use, the number of customers served, and the average use per customer. Not only does the state of business have a direct effect, it exercises definite and strong influences indirectly. This indirect effect is felt most pronouncedly in the purchase of appliances. Increased consumption of energy for domestic purposes must come as a result of additional means of utilization of that energy, which means appliance purchases. Appliance sales, like the sales of other consumers' goods, are sensitive to the state of general business, and consequently fell off during the early part of the depression, but show an upward trend from 1933 on, thus increasing energy sales. When the public purchases appliances, the first cost or purchase price is the determining factor, cold analysis shows. Appliance ownership varies with family income.

MR. HALL

In the analysis of residential energy use, domestic kilowatt-hour sales from 1883 to 1938 have been plotted as shown in Figure 1. Values from 1883 to 1925 have been estimated by the E.E.I., those from 1926 to date being actual values. To the actual plotted values a trend line has been fitted. Domestic sales show a substantial increase up to 1930 when the effects of the depression became felt. From 1932 to 1936 the actual sales fell below the trend line. The year 1937 was the first value to fall above the trend since the start of the depression.

In order to show graphically the rates of increase, this curve of total domestic sales has been plotted on semi-logarithmic paper in Figure 2. This curve shows

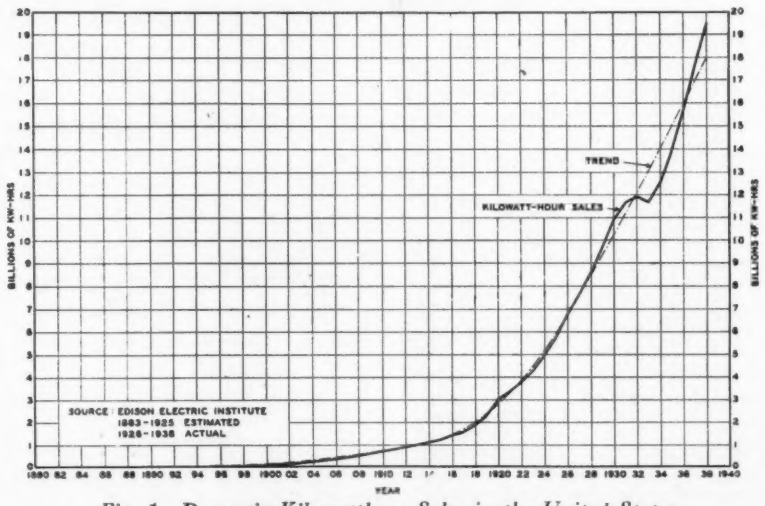


Fig. 1. Domestic Kilowatthour Sales in the United States

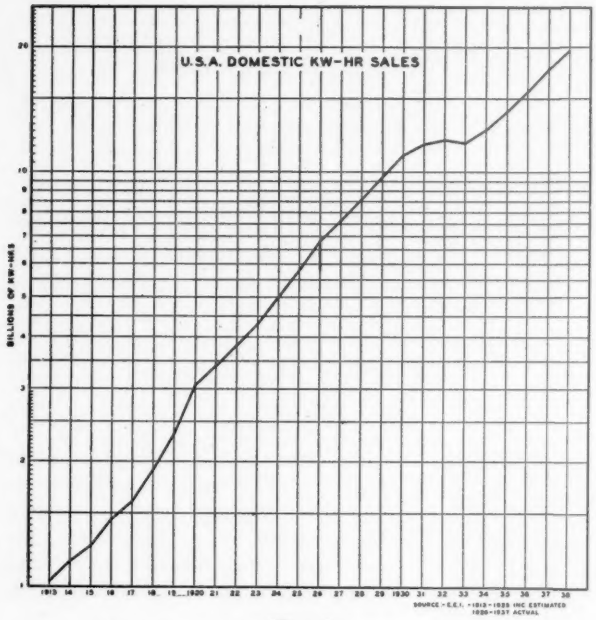


Fig. 2

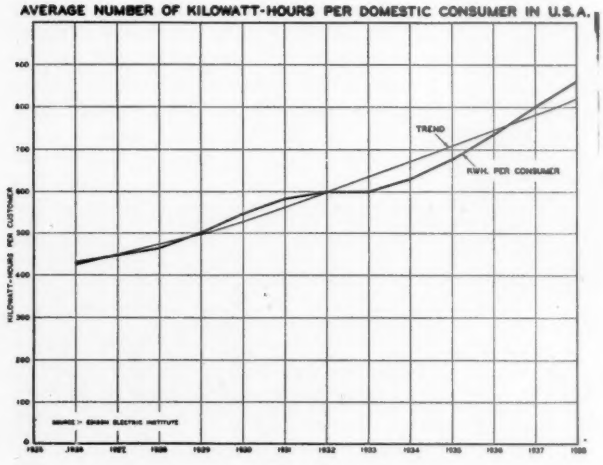


Fig. 3

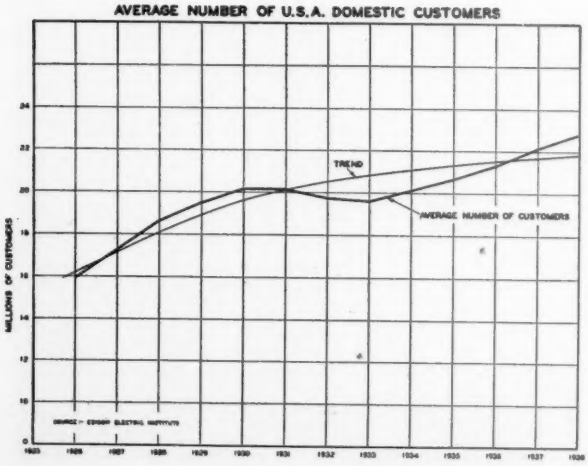


Fig. 4

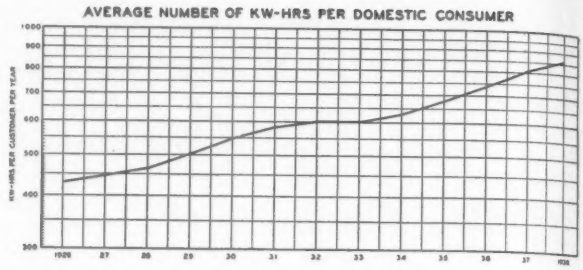


Fig. 5

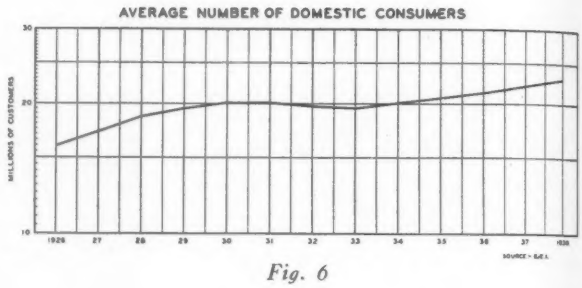


Fig. 6

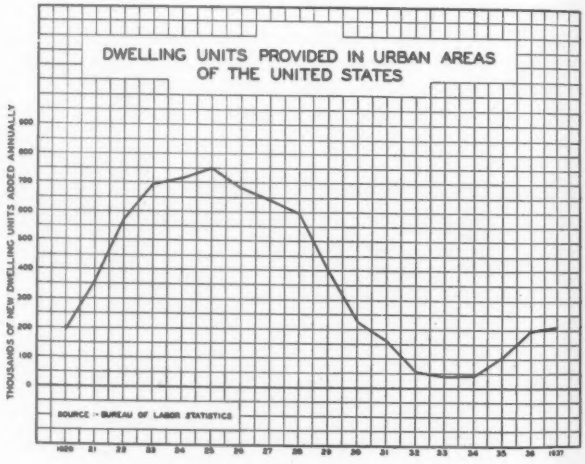

DWELLING UNITS PROVIDED IN URBAN AREAS OF THE UNITED STATES
THOUSANDS OF NEW DWELLING UNITS ADDED ANNUALLY
SOURCE :- BUREAU OF LABOR STATISTICS

Fig. 7

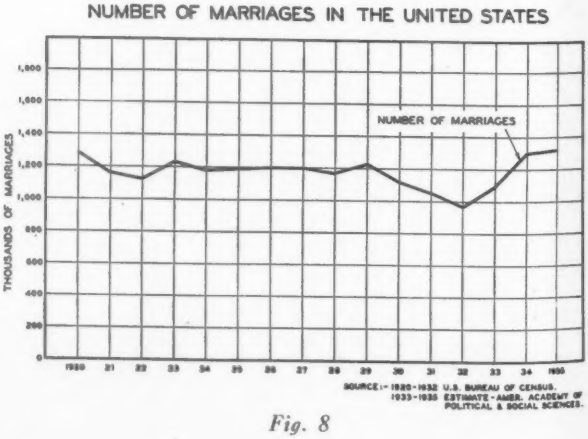

NUMBER OF MARRIAGES IN THE UNITED STATES
NUMBER OF MARRIAGES
THOUSANDS OF MARRIAGES
SOURCE :- 1920-1932 U.S. BUREAU OF CENSUS.
1933-1935 ESTIMATE - AMER. ACADEMY OF POLITICAL & SOCIAL SCIENCES.

Fig. 8

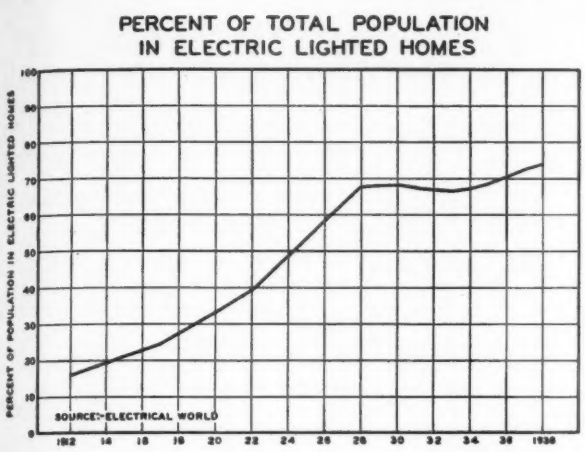

PERCENT OF TOTAL POPULATION
IN ELECTRIC LIGHTED HOMES
PERCENT OF POPULATION IN ELECTRIC LIGHTED HOMES
SOURCE:-ELECTRICAL WORLD

Fig. 9

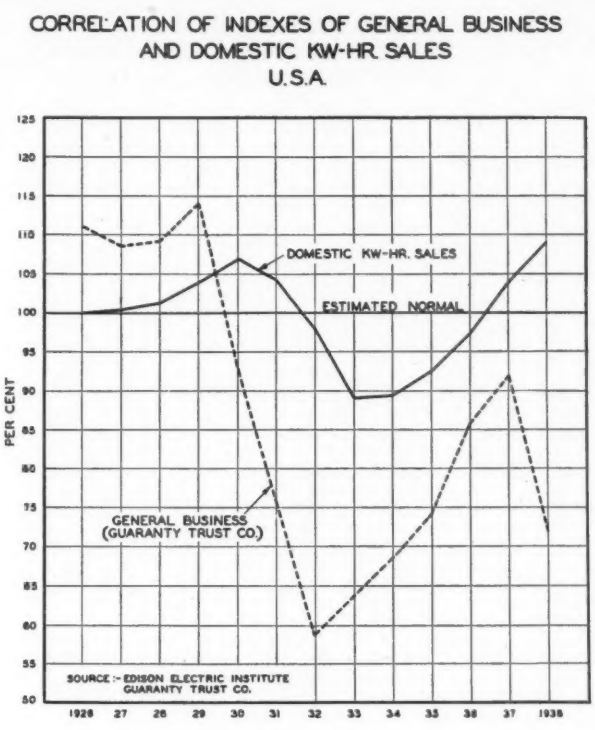


Fig. 10

a fairly constant annual percentage increase from 1926 to 1930, and thereafter levels off to 1932. In 1933 an actual decrease was experienced. After 1933 the curve rises at an increasing annual percentage rate of increase and in 1938 regained the same rate of increase as existed in the 1926-1930 period.

Domestic energy use can be divided into two factors, the average use per customer, and the number of customers using service. In analyzing the domestic use these factors have been studied. Average kwhr use per customer is shown in Figure 3 from 1926 to 1938. A trend has been fitted to the data. The effects of general business can be seen when the curve of actual values is compared to the trend. The values of use per meter have been plotted on semi-logarithmic paper in Figure 5, to show rates of change. This curve shows an increasing percentage rate of increase in the period 1926 to 1930, and a decreasing rate of increase thereafter to 1933. The period 1933 to 1938 shows a fairly constant percentage rate of increase comparable to the average of the period 1926 to 1930.

The number of domestic customers served is shown for the period 1926 to 1938 in Figure 4. The effects of the depression can be seen even in the number of customers served. The hollow in the curve during this period is due to the arresting of the normal increase in customers due to "doubling up" of families and postponement of marriages, and lack of new residential building.

The rate of increase of number of domestic consumers is shown in Figure 6, by the use of semi-logarithmic paper. The percentage rate of increase in the period 1926 to 1930 slightly exceeds that of the period 1933 to 1938.

The number of dwelling units provided in urban areas of the United States, shown in Figure 7, indicates one of the reasons for the decreasing number of new residential customers added to utility company lines. The number of dwelling units provided, in the period 1920 to 1936, reached a peak in 1925, and then continued falling off, attaining a minimum in 1934. The years 1935, 1936 and 1937 have shown an increase.

During the depression many families were forced to "double up," owing to economic pressure. This action, of course, resulted in a decrease of residential electric consumers. Economic pressure also forced the postponement of many marriages whose effect is shown in Figure 8. Marriages were taking place in the United States from 1920 to 1929 at a rate of approximately 1,200,000 per year. From 1929 to 1932 the rate decreased reaching a low point in 1932 of 981,000. Since 1932 marriages per year have increased, attaining in 1935 the value of 1,330,000. This temporary curtailment of the establishment of new homes has had its effect on the number of residential customers, and consequently on the consumption of electric energy for domestic use.

Another important factor to bear in mind in considering the number of residential consumers and their growth is the saturation of wired homes.

The percentage of population in electrically lighted homes in the United States is shown in Figure 9. From 1912 to 1928 the percentage increased rapidly. The saturation reached 68 per cent in 1928, and remained there for three years when it decreased slightly with the effect of the depression, and then increased from 1933 to 1938, attaining the value of 73.8 per cent in 1938. A large proportion of the present unwired homes are in rural areas, metropolitan cities reaching a value as high as 97 per cent.

Effect of Business Cycle on Domestic Kwhr Sales

In Figures 1, 3 and 4 the trends of domestic kwhr sales, use per customer and number of customers are shown. It was noticed in studying these charts that in the period before 1930 the values were above the long term trend and in the depression period after 1930 the actual values fell below this trend. This phenomenon was caused by the effects of the business cycle. One would readily expect to find that industrial power sales follow the general business cycle, but it is interesting to observe also that the sales of energy for domestic purposes is affected by the condition of general busi-

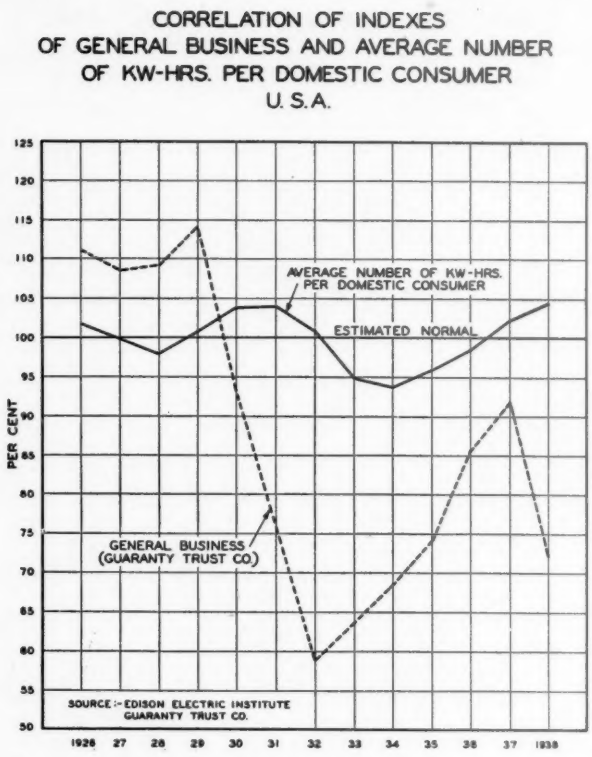

CORRELATION OF INDEXES
OF GENERAL BUSINESS AND AVERAGE NUMBER
OF KW-HRS. PER DOMESTIC CONSUMER
U. S. A.
PER CENT
AVERAGE NUMBER OF KW-HRS. PER DOMESTIC CONSUMER
ESTIMATED NORMAL
GENERAL BUSINESS (GUARANTY TRUST CO.)
SOURCE:- EDISON ELECTRIC INSTITUTE GUARANTY TRUST CO.

Fig. 11

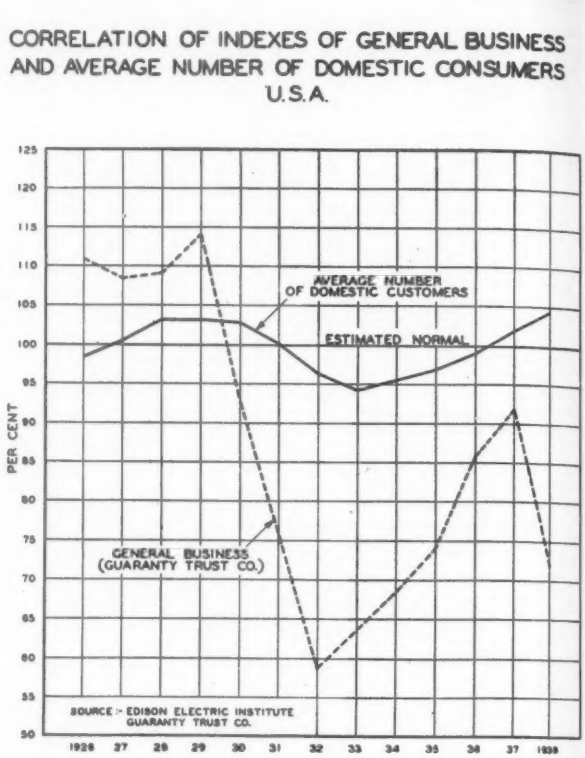

CORRELATION OF INDEXES OF GENERAL BUSINESS
AND AVERAGE NUMBER OF DOMESTIC CONSUMERS
U.S.A.
PER CENT
AVERAGE NUMBER OF DOMESTIC CUSTOMERS
ESTIMATED NORMAL
GENERAL BUSINESS (GUARANTY TRUST CO.)
SOURCE:- EDISON ELECTRIC INSTITUTE GUARANTY TRUST CO.

Fig. 12

ness. This fact is brought out strikingly in Figures 10, 11 and 12.

From the actual data of kwhr sales and the long time trend an index of domestic kwhr sales has been constructed as shown in Figure 10. On the same chart the index of general U.S.A. business activity of the Guaranty Trust Company is plotted. A glance will show the similarity in shape of the two curves. In this analysis we are not interested in the amplitude of the swings about the normal, but in the general similarity in shape. It will be noted, however, that the index of domestic kwhr does not exhibit the same degree of fluctuation as the index of general business. The index of kwhr lags the business index by approximately one year, both at the peak and at the bottom.

The index of average kwhr consumption per customer also assumes the general shape of the business curve as shown in Figure 11. The amplitude of the variations of this curve is less than the general business curve. In this case the lag of the kwhr use curve approaches a two year period behind the general business curve. The peak of the business curve was in 1929, whereas the kwhr use curve peak occurred in 1931. The bottom of the business index curve occurred in 1932, whereas the low point of the kwhr use index is found in 1934. The upward swing of this curve after 1934 closely follows that of the general business index.

In Figure 12 an index of number of domestic consumers is shown together with the business index. The general shape of the customer index is similar to the general business index. A lag of about one year is apparent.

After studying these three charts it should be apparent that the business cycle exerts a strong influence on residential consumption, in fact, it is the strongest single factor at work. Taking

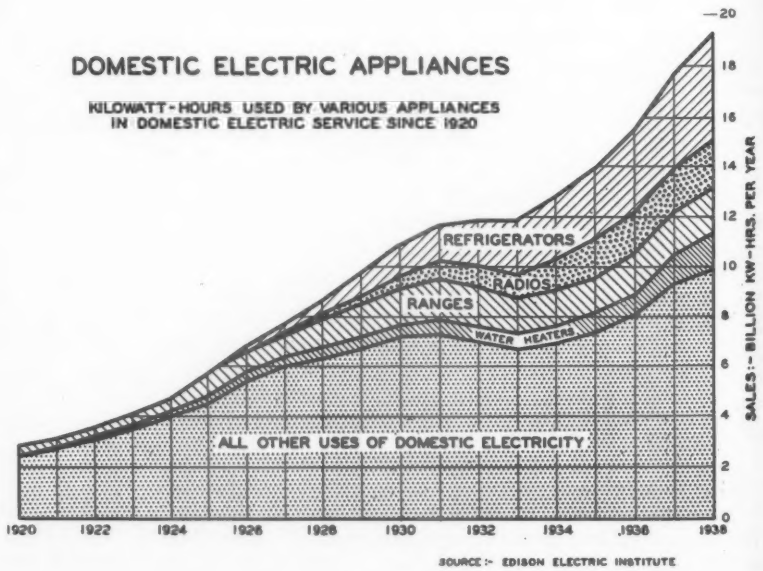


Fig. 13

the recent period of 1933 to 1938 it can be seen that the increase in residential use was to be expected as a recovery from the low of the depression as a natural result of improvement in general business.

Analysis of the Increase in Domestic Kwhr Consumption

The domestic consumer utilizes energy for lighting and appliance operation. Energy used by various appliances in domestic service from 1920 to 1938 as estimated by Mr. W. M. Carpenter of the E.E.I. are shown in Figure 13. The cumulative effect of increase in the number of consumers and in the increase in number of appliances per customer is reflected in this chart. Refrigerators, it can be seen, have accounted for a large part of the increase. Lighting and other uses have increased. Increased residential use comes from increased use of appliances. In Figure 14, the estimated use of energy per domestic customer has been plotted. Comparison of this chart and Figure 13 shows that although the energy utilized for lighting shows an increase over the period 1920 to 1938, the lighting use per customer during this period has remained practically stationary. In connection with these two charts, Figure 15 shows an interesting picture. Here the per cent of the total kwhr sold is shown for each principal appliance class. In 1920 lighting accounts for almost 80 per cent of the total residential use, whereas in 1938 lighting use represents 35 per cent of the total. In other words, the electric bill is no longer a "lighting" bill, but now is only one-third lighting. One-fifth of the residential energy sold is consumed by refrigerators. Radio sets, scarcely heard of popularly in 1920, now account for 10 per cent of the domestic energy used.

The increase in domestic energy consumption accounted for by appliances can be the result of an increase in the number in service, and increased consumption per appliance. In Figure 16, the increase in estimated energy consumed by appliances is analyzed for the period of recovery from the depression, 1933 to 1938.

During this period the kwhr used by refrigerators as a whole increased 84 per cent. The increase was due to the great increase in number of units in active service which increased 160 per cent, and in spite of a decrease in consumption per unit of 30 per cent due to increased efficiency. The range load increased 19 per cent, although the number in service increased 58 per cent, but was offset by a 31 per cent decrease in average consumption per unit. Energy used by water heaters has increased 137 per cent, due to a 10 per cent increase in energy use per unit, and a 112 per cent increase in number in service. Radio sets in active service have increased 94 per cent, with an 18 per cent increase in energy use per unit, which together have caused the total energy used by this appliance to increase 128 per cent. Other appliances (miscellaneous) have accounted for 84 per cent more kwhr, their use per customer increasing 60 per cent, while the total number of customers increased only 15 per cent. Use of energy for lighting has increased 36 per cent. This is due to an 18 per cent increase in energy use per customer, and a 15 per cent increase in number of customers. In summation it can be said that the increase in residential use during re-

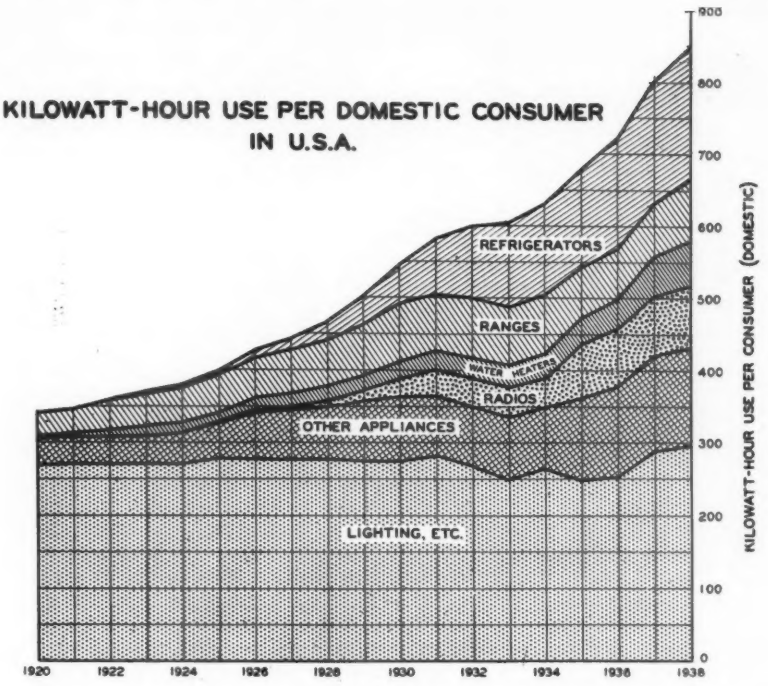


Fig. 14

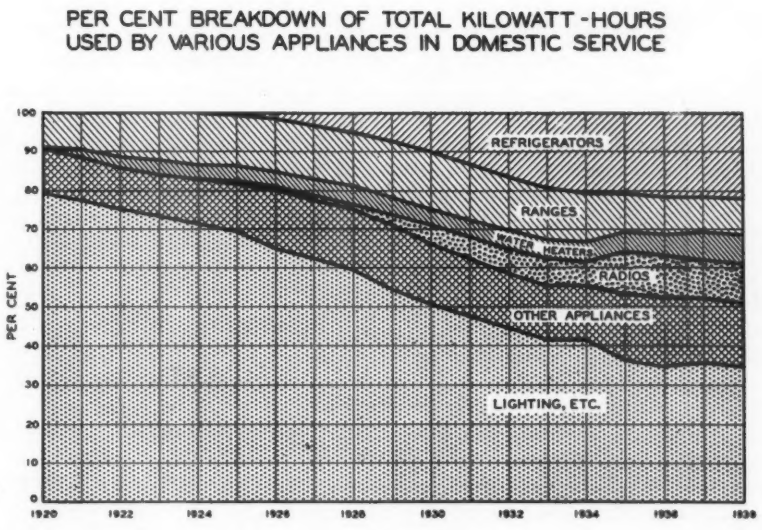


Fig. 15

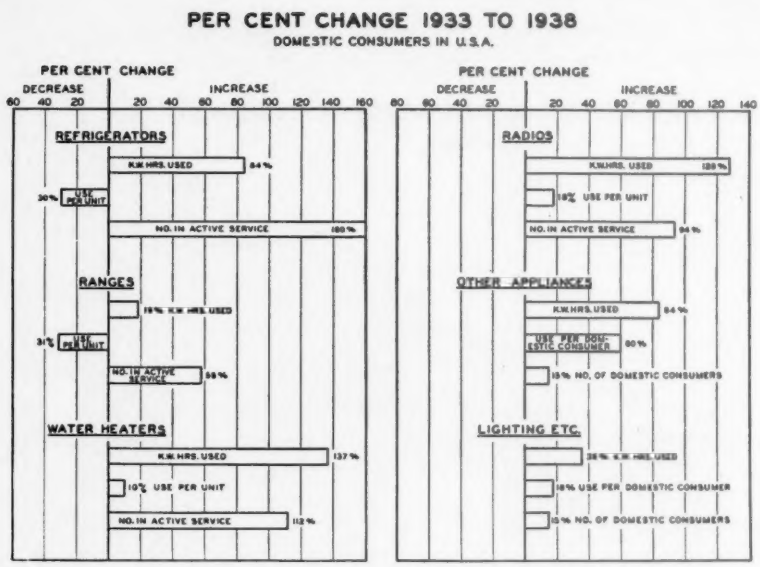


Fig. 16

covery from the depression has been largely due to increased appliance possession by consumers.

Role of Appliances in Domestic Consumption

The cost of an appliance is the principal determining factor in appliance purchases. In the preceding paragraphs it has been shown that the addition of appliances has caused the greater part of increase in residential energy. Some appliances, notably refrigerators, show a remarkable decrease in price over a period of years. In many cases even though a decrease in trend of retail prices is shown, the customer still gets more for his money through improvement and increases in efficiency.

The influence of general business activity can be seen in its effect on prices of appliances and volume of sales. It is a greater influence on volume of sales than any other single factor. Appliances with a high degree of saturation reflect the business cycle more than those of low saturation because of the large element of potential growth still present in the low-saturated appliances which has a tendency to obscure the cycle.

Let us take the domestic electric refrigerator for the purposes of demonstration. Sales of domestic electric refrigerators from 1921 to 1938 are shown in Figure 17. In the period 1921 to 1926 a slow, steady increase was experienced. The year 1926 marked the start of intensive promotional efforts. The depression halted the increasing sales but to a lesser extent than almost any other appliance. This behavior may be attributed primarily to rapidly falling prices.

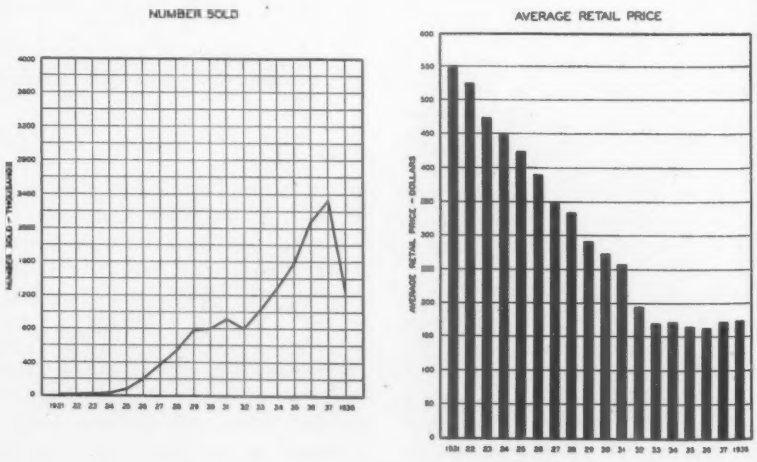
A glance at Figure 18 reveals a striking picture of price reduction, the real reason for the maintenance of the sales volume. In 1921 the average retail price was $550, whereas in 1938 it had dropped to $172, or 31 per cent of what it was in 1921. Refrigerators have now attained a saturation of 53 per cent.

Analysis of other appliances shows similar trends of prices and sales and the effect of the business cycle on both of these items. Changes of models and the introduction of the socket type set which came into commercial use in 1926 have effected the curve of radio receiver sales. Retail prices of electric clocks from 1928 to date have shown a remarkable decrease which has had an important effect in stimulating sales. In 1928 the average retail price was $30.77 but in 1938 it had decreased to $4.80, or 16 per cent of the 1928 value. Growth of water heater sales had been slow up to 1930 when sales fell off as a reflection of general business activity. The water heater market is still relatively undeveloped in many parts of the country and has been largely promoted by utilities where it has been promoted at all. Vacuum cleaner sales show a marked sensitivity to general business conditions due to the highly saturated market. The sales of washing machines show the influence of general business activity. The washing machine market has now reached a saturation of 49 per cent. It is estimated that about 46 per cent of washing machine sales involve trade-ins. Flatiron sales, because of the high saturation, estimated at 102 per cent, are quite sensitive to business conditions. Average retail prices of toasters have shown no distinct trend. The modern toaster with its automatic timing devices, however, is quite a different appliance from the toaster of 10 years ago.

Appliance Possession Varies with Income

Through studies of consumers' buying habits in the past few years it has been shown that appliance possession increases with income, thus emphasizing the fact that first cost of the appliance is uppermost in the customer's mind when purchasing. From the publication of the U. S. Department of Commerce, "Consumer Use of Selected Goods and Services," Figure 19, has been prepared.

These data, showing how mechanical



Figs. 17 and 18—Electric Refrigerators

refrigerator saturation increases with family income, are the composite for the 32 cities studied. Saturation begins at 4 per cent for the $1-499 income group, and attains 78 per cent for the $5,000 and over income group.

Electric range saturation has been plotted in a similar manner in Figure 20. To secure an accurate picture only cities having an appreciable range saturation have been included, which brings the number of cities to four. The same trend in ownership of ranges obtains as with refrigerators. In the lowest income group of $1-499 annually the saturation is 7 per cent and it rises steadily to the highest income group where it reaches 62 per cent.

A study of appliance sales curves shows in practically every case that sales were strongly affected by general business conditions. In Figures 19 and 20 it is shown clearly that appliance purchases and ownership depend upon income. It would be interesting therefore, to see what happened to the national income during the period that has been studied with regard to appliances.

National income payments to individuals from 1920 to 1938 are shown in Figure 21. This is the income available for purchases of appliances and all other goods, and it naturally follows that appliance sales would follow this curve. This is the case, as a review of the appliance sales curve will show. Recovery from the low income year of 1933 to date has resulted in a similar recovery in appliance sales, and pursuing this line one step further as a result of increased appliance ownership, domestic electric energy consumption has increased.

Residential Lighting

Residential lighting, although accounting for a smaller proportion of the domestic customer's energy use, still remains an important part of the load.

Sales of residential incandescent lamps are available from 1928 to date and are shown in Figure 22. Lamp sales show some effects of the depression, but not to the extent of other devices because of their being in the necessity class. A sharp and steady increase from 1933 to date is seen.

Remarkable progress has been made in incandescent lamp development and production since their introduction. In Figure 23 average retail prices of residential incandescent lamps are shown. As far back as the data are available a steady decrease in price is shown. The average price of 1938 is one-half that of 1928. In these data all sizes and types of residential lamps are included. However, in Figure 24, the prices of two common sizes of lamps are shown. The 60 watt lamp in 1908 sold for $1.75, and its price has decreased until in 1938 a 60 watt lamp cost 15 cents. The 25 watt lamp cost 85 cents in 1909 and now costs 15 cents. On top of this great reduction in prices, considerable increase in lamp efficiency has taken place. The General Electric Company states that lamp efficiency, if the year 1921 is taken at 100 per cent, would be 145 per cent at the present time.

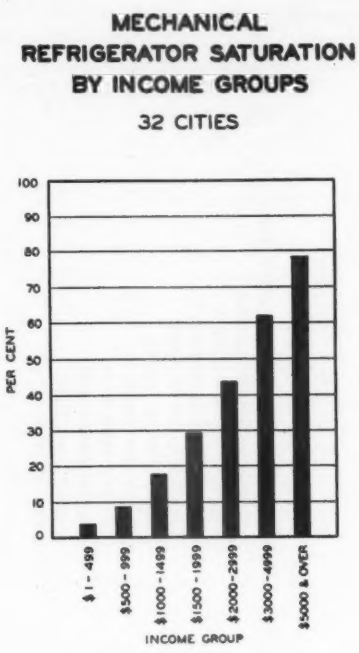


Fig. 19

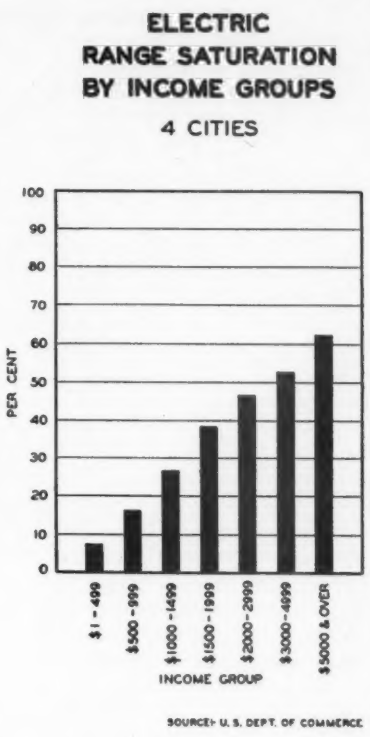


Fig. 20

Appliance Promotion

The vast volume of appliance sales has not come about without effort on the part of the utilities and manufacturers. National and local campaigns and advertising, and all the tools of merchandising have been used. As an indication of the amount of effort behind the promotion

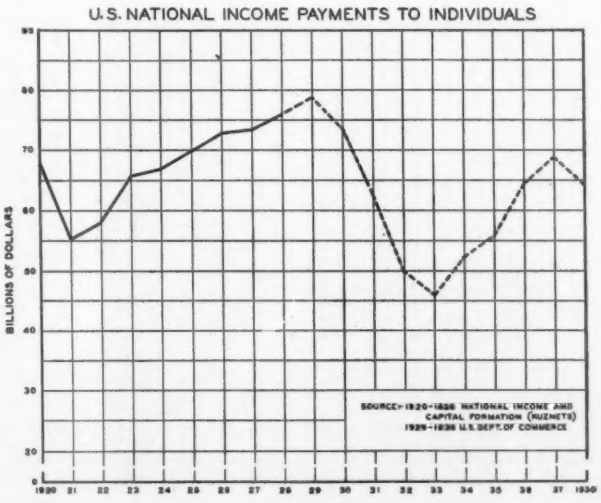


Fig. 21

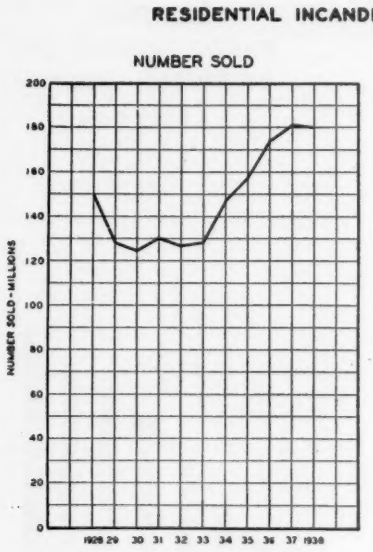


Fig. 22

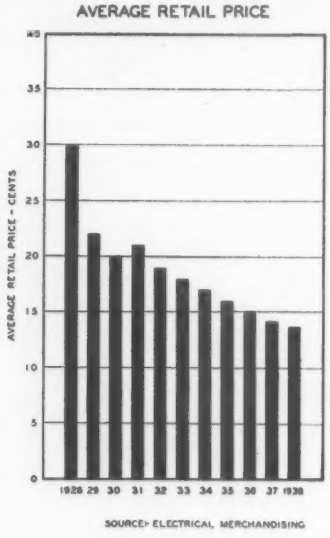


Fig. 23

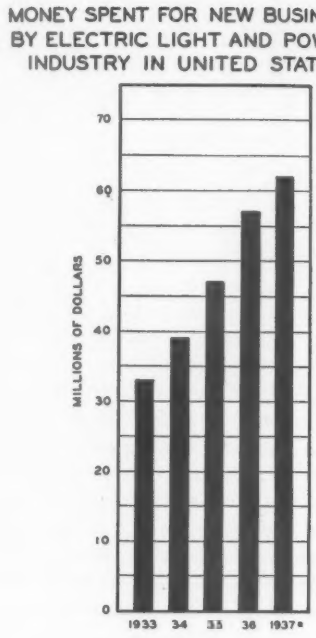


Fig. 26

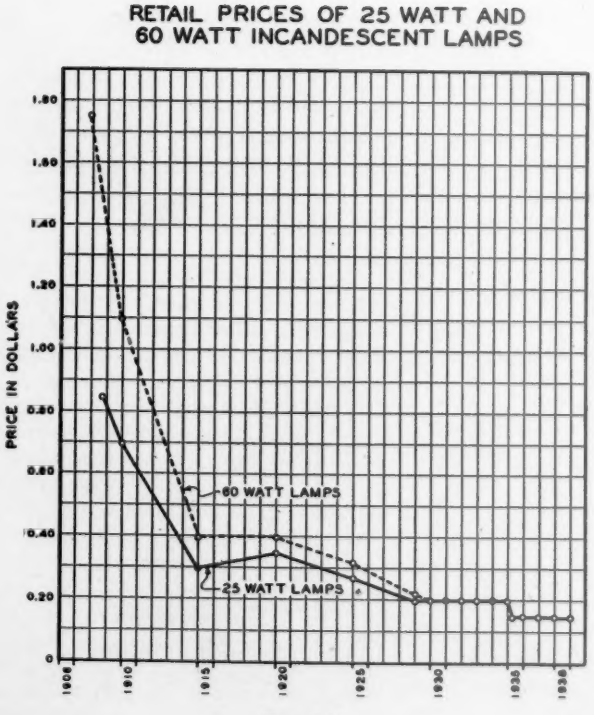


Fig. 24

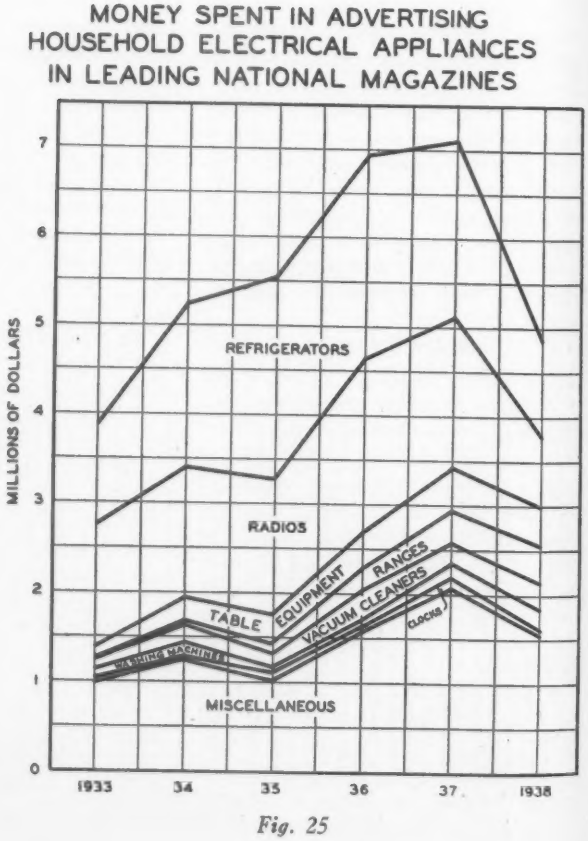


Fig. 25

of appliances it has been possible to obtain the expenditure for household electrical appliance advertising in leading national magazines from 1933 to 1938, as shown in Figure 25. This amount has shown an increase in that period similar to the increase in appliance sales and kilowatt hour consumption. In 1933 the amount expended was $3,900,000, which rose to over $7,000,000 in 1937 and, following the general business trend, decreased to $4,900,000 in 1938. The chart also indicates a breakdown of expenditures by appliances advertised. It can be seen that more money was spent for advertising refrigerators and radios than for any other appliance. This is particularly important since it has been established that the increased use of these two appliances accounts for about two thirds of the increase in domestic energy consumption in the past ten years.

The utility companies have continuously promoted appliances by one means or another since their start. As an indication of the magnitude of utility promotional efforts, the total new business expenditure of these companies in the United States is shown in Figure 26. This includes, of course, all types of activity for the acquisition of new business of all kinds. New business expenditure in 1933 amounted to $33,000,000 and increased steadily to 1937 when it reached an estimated value of $62,000,000. This expenditure, a good part of which was used by the utilities for promoting domestic appliances and for inducing increased domestic consumption, must have had an important effect on the use of energy for residential purposes. Other factors, such as lowered rates and convenience of electric appliances, undoubtedly have had some influence on the growth of the domestic load.

The fact that lowering of rates does not necessarily mean increased demand for electricity might seem to be a contradiction to the well recognized economic principle of price and demand. The fallacy of the application of this thesis is not the principle itself, but in the consideration of the factors involved. The principal fallacious assumption is that people buy electric energy as such, distinct from the service it renders. The fact is that people do not buy electric energy as such, but buy light, heat, refrigeration, cleanliness, convenience, luxury. But these items in themselves are abstract things. You cannot buy them by the pound. What people actually buy as far as the application of this economic principle is concerned, is appliances which employ electric energy in their supplying of those wants. A good illustration of this point is the automobile and its source of energy, gasoline.

In purchasing an automobile the buyer gives slight consideration to the price of gasoline. He is purchasing transportation, recreation, convenience, luxury. A few cents variation in the price of gasoline will not affect his determination to go for a ride. And if the price of gasoline is reduced a few cents, he will not travel more than his customary habit.

In the period stated, however, the statistics indicate that appliance purchases (directly translatable into energy consumption), are influenced principally by business activity, first cost and promotional efforts in merchandising. The electric refrigerator is a striking example.

The refrigerator has accounted for more of the load increase in the past few years than any other appliance. Yet this appliance does not justify a special rate, being added to the system on the prevailing residential rate, although of course, by virtue of its addition, the average unit cost per kilowatt hour is lowered. Nor is it believed that a decrease in rates would materially influence the sale of refrigerators for it has been demonstrated that the controlling factors are the first cost and general prosperity of the country. The very fact that business exerts such an influence on sales is in itself a strong indication that first cost is uppermost in the customer's mind. The importance of the influence of first cost and general business is emphasized when the record of the price of electric energy, which has had a steady downward trend since 1913, is compared to the fluctuations in sales volume of appliances over the same period.

"Old Ice Box Round-up" Is Launched

DECLARING that the revival of business enterprise was the "No. 1 problem in this country," Floyd L. Carlisle, chairman of the board of Consolidated Edison Company, on the evening of March 14 helped to launch the largest cooperative campaign for the sale of automatic refrigerators yet attempted by the industry. The campaign, which will be known as "The Old Ice Box Round-up," begins March 20. Addressing an audience of more than 2000, gathered in the grand ball-room of the Waldorf-Astoria and made up of representatives of 13 cooperating refrigerator manufacturers, 12 distributors, 875 approved dealers and banking, advertising and utility representatives, Mr. Carlisle said that the solution of practically all other major problems depended on and would naturally follow the revival of business.

In his talk, which was picked up and cut into Consolidated Edison's regular Tuesday night broadcast over Station WJZ, Mr. Carlisle said: "The economic well-being of modern society is dependent primarily on the volume and velocity of the turn-over of goods and services. All government activities—education, social welfare, national defense, etc.—as well as wages, interest, taxes, are paid from this source. There is no other source. The natural inclination of people is to consume more goods and enjoy the many material things that mass production has made possible in America. American business is devoting iteslf to satisfying this demand for goods by producing more and better goods at lower prices."

Details of the campaign were announced by E. F. Jeffe, vice-president, Consolidated Edison, who was toastmaster. J. S. Knowlson, chairman of the board of Stewart-Warner Corp., spoke for the manufacturers and M. H. Aylesworth, publisher, *New York World-Telegram*, presented his reactions to the campaign.

Because of attractive prices set by the manufacturers for 1939 model refrigerators, an allowance of $9.50 for each old ice-box replaced by an automatic refrigerator, and low rate financing terms, it was predicted that in the four months of the campaign sales amounting to $10,000,000 would be made.

Mr. Jeffe said the objective of this campaign was the same as that of the recent "bargain package" drive which accounted for more than 900,000 appliances with a sales value in excess of $5,600,000—business recovery through "jobs for men" and social improvement by making available standard approved appliances at bargain prices; on easy payment terms for low income bracket customers.

Recent Developments in Cable Fault Locating

By James A. Vahey

Fault Location Engineer, Transmission and Distribution Department, Boston Edison Company

A paper presented before the Meeting of Subject Committee on Underground Methods and Accessories, Transmission and Distribution Committee, E.E.I., Rochester, N. Y., Feb. 8, 1939

THE location of faults, with speed, accuracy, and economy, especially in high voltage transmission cables is of the utmost importance in the operation of a power system. Two general methods, the tracer current method and the bridge method have been generally applied for fault location.

The exploring coil or tracer current method of fault locating has been in continuous use in the Boston Edison Company for twenty-five years and with the improvements made during recent years, has now reached a highly satisfactory state of development. All of the tracer current apparatus known under the name of the Lundin Fault Locator, together with the methods of use, were developed on the Boston system by the writer over this period of time.

The apparatus and methods were described, and the theory and principles discussed, by Mr. W. B. Elmer of the Boston Edison Company, in a paper presented by him in New York on February 2, 1932, at a Fault Locating Symposium held by the Underground Systems Committee of the N.E.L.A. Mention was made at that time by Mr. Elmer, of some new methods and apparatus which had just been developed. During the six years intervening, these developments have been constantly and successfully in use, and it is the purpose of this paper to describe them in some detail.

Review of Older Equipment Used in Conjunction with New Equipment and Methods

Briefly, the Lundin fault locating apparatus consists of three main parts. The first is the Analyzer, which applies voltage to the fault and carbonizes, when possible, a path across the insulation. A signal lamp on the analyzer, gives some idea of the nature of the fault. The second part is the Interrupter, which sends a certain tone through the faulty circuit, and the third is the Exploring Coil, to pick up the signal in the field.

The tracer current method can be used alone or in conjunction with Bridge or Loop measurements, to locate the fault exactly, without opening joints, where the fault is not visible. It can be used where accurate Loop measurements are uncertain or difficult.

The Lundin apparatus and methods are used on every type of fault both overhead and underground, on either live or dead circuits. No technical education is necessary for the operator, and everything is designed for use by the regular troubleman.

The exploring coil is heavily insulated, and is applied over the sheath or covering of the cable. No fireproofing is removed, or contact made by probes with the sheaths of cables.

The signal sent out by the Interrupter is readily recognized, and is wholly unlike that of any other sound picked up by the exploring coil.

In using the sector exploring coil on three conductor cable, with a low resistance fault on one conductor, there is a "hump" or louder signal in one spot on the sheath, in the signal when going circumferentially around the cable with the coil, before the fault, and no "hump" beyond. This "hump" is at a maximum when the coil is directly over the faulty conductor due to the eccentricity of the conductor. Because of this relation there is also a faint "hump" (due to sheath current) when the coil is applied directly opposite the conductor carrying the fault current.

Fig. 1—Analyzer

Beyond the trouble, the return current on the sheath is in concentric relation to the cable axis and there being very little current in the faulted conductor, especially if the fault is of low resistance, there will be no "hump" to the signal regardless of its volume.

With high resistance faults, such as those submerged in fresh water, the "hump" effect may be obtained beyond the fault due to the capacitance of the faulty conductor. This effect may be greatly diminished by reducing the fault to the lowest resistance possible and avoiding the application of voltages higher than 230 or 350 to the cable.

Equal currents in the conductors of a multi-conductor cable will produce a resultant field concentric with the cable axis due to the helical lay of the conductors and opposed by the field of the sheath return current which is in the opposite direction. With a high resistance ground on one conductor, the current in that conductor will be greater than in the others by the small amount of fault current and a "hump" in the signal will be obtained up to the fault. Beyond the trouble, the charging current is very nearly equal in all the conductors and the sound will be of the same intensity all around the cable. If the three conductors had not been connected to the locator, the charging current of the faulted conductor beyond the fault would have produced a "hump." This "hump" effect beyond a fault has been termed "steal."

Tuned Sector Coil

These pick-up effects are more pronounced with the newest type of coil, known as the Tuned Sector Coil, which is tuned to the frequency of the interrupter, making it easier to hear small amounts of fault current, and is especially useful when locating trouble on heavily loaded a-c circuits. It is particularly of value in identifying and tagging conductors carrying heavy loads.

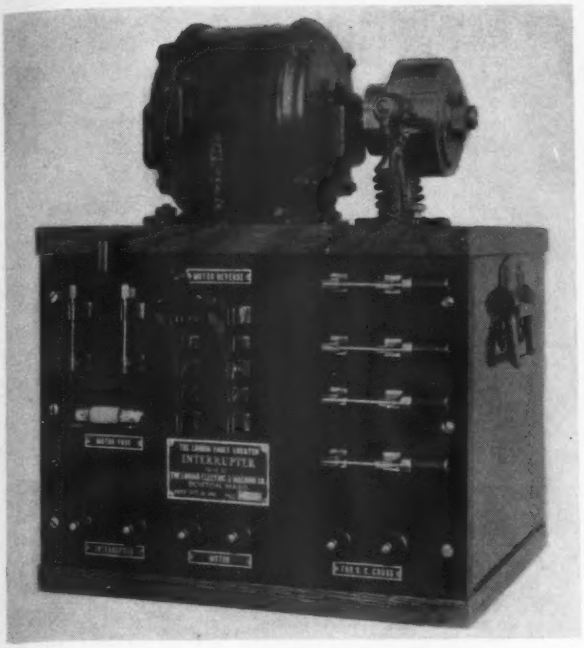


Fig. 2—Interrupter

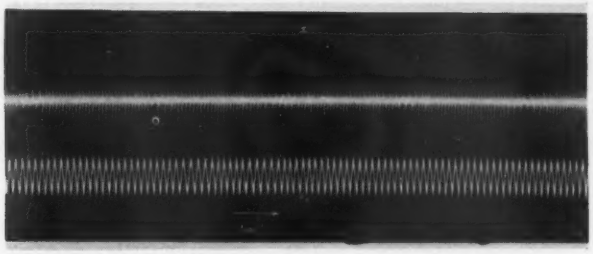


Fig. 3—Interrupter Current Wave
"I" Output Current—"E" Timing Wave (60~)

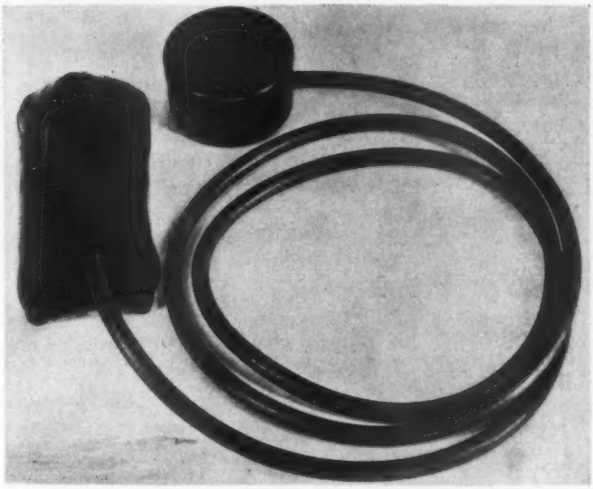


Fig. 4—Tuned Sector Exploring Coil

This coil has not yet been introduced outside of the Boston Edison Company.

Loop Coil Method

The location of cable faults by tracer current is obtained by a decisive difference between the signal received before and after the point of trouble. In the early days of using this method, this difference was usually one of volume only. The writer has striven particularly to obtain increased differences in characteristics on either side of the fault, in order to assist in locating the trouble.

This has been accomplished by the development of the loop coil method, which has also made possible the tracing of cable faults from above ground while driving over the route in an automobile.

The success of this method depends on the fact that there is more than one cable in the duct line, and that the sheaths are bonded, preferably in every manhole.

Fortunately for the success of this manner of chasing underground trouble, the present trend is to bond cable sheaths frequently, usually in each manhole. Also, there are generally two or more cables in a duct line.

The loop coil is round, encased in a bakelite case and is about 12 x 1½ inches overall. It has a removable holder, which is used to attach it to the trouble-hunting automobile. The outfit is waterproof, making it available for any sort of weather.

While the exploring coils used in the past utilized but one field, the loop coil uses two fields.

When held in a vertical position, it is sensitive to the vertical field caused by the loop made by the current in the faulty conductor, and the return current on an adjacent sheath.

This vertical or loop field is very powerful, and is the one most used.

When held in the horizontal position, it is sensitive to the field which comes from the current in one conductor only, or ground, and this is used as a check on the vertical field, especially on buried cables. These fields are illustrated in the diagram.

The earlier types of surface exploring coils such as the triangle (developed by the writer) while powerful in pickup were adapted to use the horizontal field only.

For this reason, when the fault was passed, the signal received was often of the same volume for some distance ahead, and an accurate location above ground was difficult.

With the loop coil in the vertical position, it can pick up the field produced by the loop of fault current flowing out in the conductor, and back in the sheath. Beyond the fault the sheath current flows ahead in the sheath, and there is no current loop and corresponding vertical field over the line.

For the reasons stated, if the current is "one way," that is, ground return only, with no loop, the horizontal signal will be louder than the vertical.

In tracing cable grounds in duct lines, the vertical position is ordinarily sufficient, but in tracing faults in buried cables, both the vertical and horizontal positions are useful.

The success of the loop coil method depends on one of the fundamental differences between direct and alternating current circuits. With an insulated conductor carrying direct current and the far end grounded, the return current through the ground will divide strictly according to the resistance of the paths.

With alternating current, because of reactance, the return current will follow quite closely the route of its mate, the outgoing current. This is true, even though there may be a lower resistance path home.

For this reason, we have a loop of current along the duct line, which loop

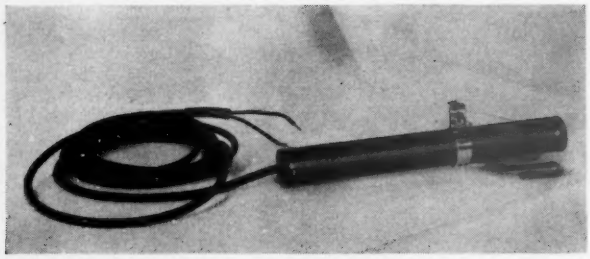


Fig. 5—Loop coil with holder to attach to automobile

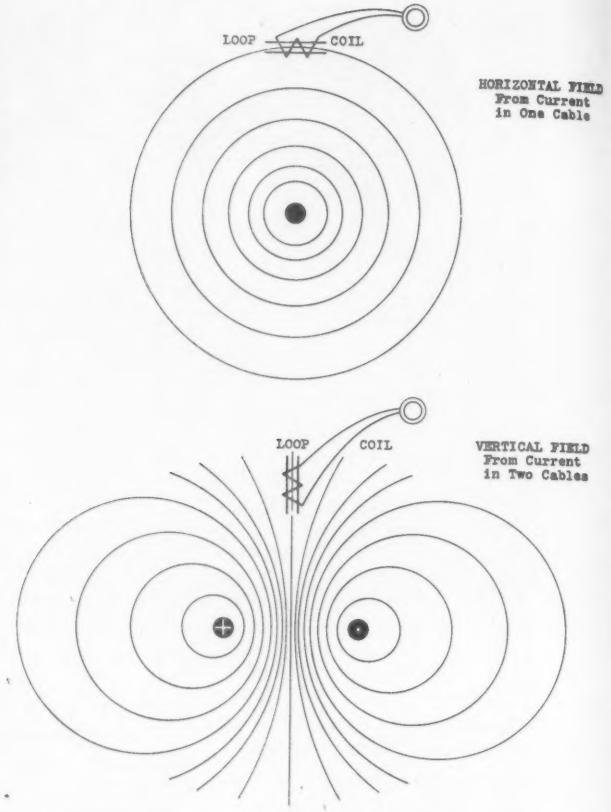


Fig. 6—Diagram of fields used by Lundin Loop Coil

in the case of a low resistance fault, scarcely ever goes beyond the next bond ahead of the fault.

In practice, on faults capable of being carbonized, the troubleman in his automobile usually narrows the location of the trouble to two holes, knowing that the fault is in either one, or in the section between.

The loop coil is attached to either the front or rear bumper of the trouble car and is connected to an amplifier in the car.

In order to obtain from cables a sufficient signal above the surface of the ground, the amplifier is absolutely necessary.

The troubleman using ear phones, drives over the cable route, until the characteristic sounds are obtained.

The loop coil and amplifier are tuned to each other to obtain maximum signal. The amplifier has been constructed to give either one of two tones, one of high, and one of low pitch. The troubleman chooses the tone best suited to bring in the interrupter signal over other sounds heard.

If the fault is well carbonized, it is not necessary to patrol all of the route from the station. Listening may be done at certain selected spots, known to the trouble-hunter, and the location speeded up. These spots are selected because they are easily accessible in the car without interference from traffic, and give good sound. For instance, on a recent burnout on an important 25,000 volt transmission cable, 10 miles long, the troubleman drove rapidly along the cable route, listening at certain places and found the fault in the first manhole he opened. No bridge measurement was possible in this case due to the manner of involvement of the conductors.

With high resistance faults, such as those under water, where a higher voltage tracer current must be used, and the danger of steal is greater, the troubleman proceeds more slowly, going over all of the line from the station. In these cases, he will be satisfied to get into a zone of four or five holes, before getting out of his car to check up, and final check is made with the new "water stick" which will be described later.

It frequently happens, especially on large systems, that a conductor burns off under water. This type of fault is much easier to locate with the loop coil, than the one in which the conductor is continuous, since the steal is eliminated by the break in the conductor.

For this reason a continuity test is made of the conductors involved in a water fault before starting out. This is easily done with the analyzer. If a conductor is burnt off and is under water, only that one is used for the fault circuit. (Although faults under water are in general the hardest to locate, they are the easiest to analyze with the fault locating apparatus.)

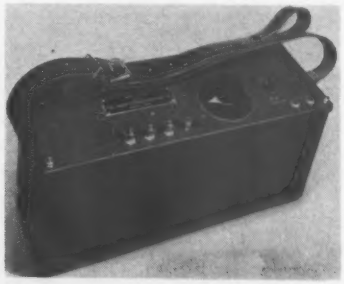


Fig. 7—Amplifier

The loop coil will of course respond to a loop of ground current as well as a loop between conductor and ground. For the reasons already stated, on a well carbonized fault, the ground loop rarely gives indication beyond one bond ahead of the fault. If, however, there should be a loop between the cable sheaths and other nearby ground structures, such as car tracks or water pipes, sending some current beyond the fault, it is determined in the following manner:

While it is not always necessary, with low resistance faults, to drive directly over the duct line, the troubleman checks up once in a while by doing so. If the signal received, becomes stronger than that obtained off-side of the duct line, he goes ahead. If the signal is just as good off-side from the duct line, or perhaps better, he goes back. The off-side signal is caused by the ground loops mentioned.

To summarize, the one characteristic common to both high and low resistance cable faults, making possible the loca-

tion by the loop coil method, is that some of the fault current will return on adjacent sheaths. This ground current will form a loop which ends at, or very near, the fault. Discrimination between this loop of fault current and other charging or leakage currents, is fairly easy with a carbonized fault. With a high resistance, or water fault, it is not so easy, requiring more skill and experience on the part of the trouble-hunter, but it can be done in practically every case. All this is accomplished without getting out of the trouble-hunting automobile until very close to the location of the trouble.

On the Boston Edison System in the year 1937, 50 per cent of the service failures on transmission cables were water faults, and in 70 per cent of these, one or more conductors were burnt off.

The average depth of cables on the Boston Edison System is about eight feet. Signals have been received from much greater depths than this, such as from tunnels under rivers.

If not enough signal should be obtained on account of the depth of cables, it would be only necessary to remove the manhole cover and lower the loop coil a sufficient distance to obtain adequate sound.

Special Uses of Loop Coil Method

In one instance, a submarine cable burnout was located with the loop coil which gave a doubtful zone of something less than a hundred feet for the fault, this location being made with the coil in a boat, fifty feet over the cable.

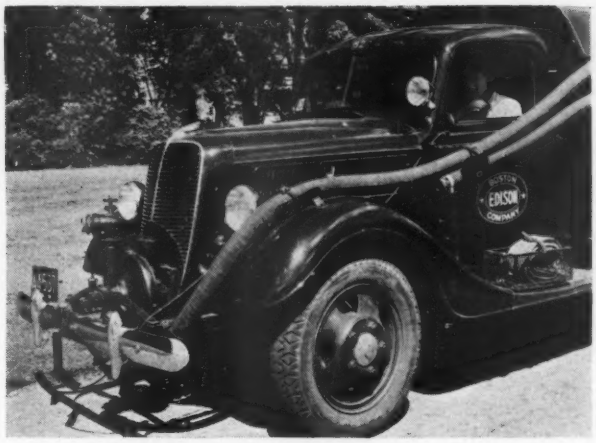


Fig. 8—Troubleman starting out to locate fault. Loop coil on front bumper of car

During a week of considerable snow on the ground, last winter in Boston, there were five grounds on five different street lighting cable circuits. The troubleman opened just five holes, one on each circuit, using the loop coil method.

Some time ago on the Edison 25,000 volt system a short circuit was located in a certain long section. It was impossible to pull the cable out. This indicated a faulty duct. Several other 25,000 volt cables were in the same conduit line. Fortunately there was a spare duct. The fault being a three phase short circuit, no bridge measurement could be made.

Tracer current from the interrupter was sent into the short circuit. A long cord was attached between the amplifier and the loop coil, and the coil drawn into the spare duct, about eighteen inches from the one in trouble, and surrounded by heavily loaded cables. The exact spot of the trouble was easily located.

In attempting to withdraw the coil, it was also caught in the duct. Subsequently the lines were killed, the ducts

Fig. 9—Troubleman tracing short circuit in buried cable using loop coil in vertical position

Fig. 10—Troubleman tracing short circuit in buried cable using loop coil in horizontal position

Fig. 11—Troubleman locating ground on buried cable loop coil in vertical position with maximum pickup

repaired at the spot indicated, and the cable and coil retrieved.

Another interesting application of the loop coil method is the locating of what is known as the "thumper" type of fault. This sometimes occurs in a high voltage kenatron proof test. At the test voltage allowed, a low resistance carbonized path cannot always be made across the fault (usually in a paraffin-filled joint).

At more or less regular intervals the cable discharges as a condenser, both ways, into the fault. The usual way to locate this type of fault is to listen for the thump of the discharge with the naked ear, at each hole. This is a long and tedious process. In these cases, the discharge current increases from either end, and is a maximum at the fault. By driving slowly over the cable route, using the loop coil and amplifier, these characteristics are noted, and the fault usually located within a couple of holes either side of the break.

The loop coil is of particular advantage in locating trouble on buried cables. Use is made of the two different fields previously described.

A short circuit is much easier to locate than a ground. In these cases, the coil is held in the hand and the amplifier suspended from the shoulder.

If, when over the cable, the vertical signal is equal to, or greater than, the horizontal, it indicates that the trouble is ahead. If the horizontal predominates, or there is no vertical, it indicates that the fault has been passed.

If the above holds true on a ground fault, it can be located in the same way.

Another method applied to ground faults, is as follows:

The troubleman lets the loop coil hang by its cord in the vertical relation, close to the surface of the ground. He crosses the cable at right angles now and again. Before the fault, the signal will be lowered when directly over the cable, but will not cut out.

After the fault, when directly over the center of the cable, and swinging the coil gently from side to side, there will be a null point in the signal.

Water Stick

Before starting out to locate, the troubleman can be assured that if the fault is under water he will only need to pump one hole to find it. This hole he will find with the aid of the newly developed "water stick."

The water fault is first localized to within a very few manholes, each of which may be filled with water, by the regular method. If the fault is not evident in any of the manholes, the troubleman lowers the water stick into the water in one of the holes.

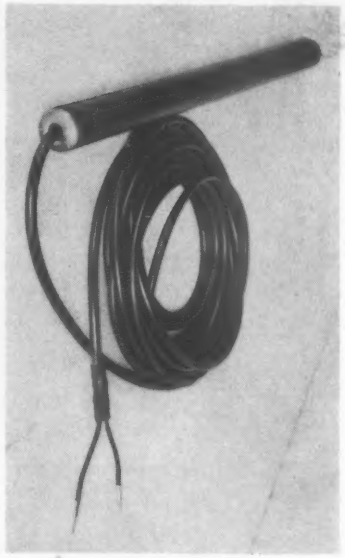


Fig. 12—Water stick

The water stick is not a coil, but a potential measuring device, and paradoxical as it may seem, the higher the resistance of the fault, the easier it is to locate it by this method.

The water stick is connected to a telephone receiver, or to the amplifier, preferably the latter. By swishing the stick around in the water it can be easily determined whether or not the fault is in that hole.

If the stick is lowered into the water in a manhole away from the fault, there will be either no signal, or when swished about in the hole, the signal will not change.

If however, the fault is in the hole, or nearby in the duct, there will be a noticeably louder signal, which is very much increased when one end of the stick comes closer to the fault.

Water faults have been located when 70 ft. or more into the duct from the manhole by the use of the water stick and amplifier.

Locating Manholes with Loop Coil

While locating a fault by driving over the cable route, it will be noticed that the loop signal is always loudest just at the edge of the manholes. This characteristic is made use of in locating the manholes, where necessary, in case they are covered with soil or snow, or if greater volume of signal is desired.

Locating manholes carrying alternating currents can be accomplished with the loop coil and amplifier, with the load currents of the cables only, if desired.

This effect is caused by the broader loop existing between the cables as they spread out in the hole. The optimum width of loop for the coil is about eighteen inches.

Live Line Indicator

It may not be amiss to mention the latest development of the writer, although not primarily for fault locating. This device is known as the Live Line Indicator.

It was developed to serve as a safety device for determining whether a line or cable (particularly a cable) is alive or dead, before cutting into it. It was designed especially for use on 60 cycle a-c lines and cables. It is applied only to the insulation of a conductor, and will indicate from 100 volts upward.

On overhead lines, of 13,000 volts upward, it can be determined on the ground, whether the lines are alive.

Another use of the indicator is the phasing of lines, either overhead or underground, without the use of transformers or other instruments, and with no connection to the conductors, except on the insulation.

Fig. 13—Live line indicator

Design of Substations for Accident Prevention

A Psychological Approach

By Morris S. Viteles, Ph.D.

Director of Personnel Research and Training, Philadelphia Electric Company—
Associate Professor of Psychology, University of Pennsylvania

A paper presented before the Electrical Equipment Committee, Edison Electric Institute, Buffalo, Feb. 7, 1939

IT has been suggested that in the electric industry there is wide room for modifications in the design and installation of substation equipment with a view of reducing the liability to accident and error entailed in the operation of such equipment. This proposal appears concretely, for example, in a statement by S. M. Dean, Chief Assistant Superintendent, Electrical System, of the Detroit Edison Company, who, in a letter addressed to members of the Electrical Equipment Committee, Edison Electric Institute, writes:

"Any individual who finds himself in a dangerous situation makes a mental 'size-up' of that situation, taking into account the various hazards as he sees them. Having made such a 'size-up' in his mind, he goes on about his work depending upon that 'size-up' automatically to warn him if he gets near the danger zone. If the dangerous situation is one that is changing, that is, such as one meets in crossing a busy thoroughfare, the individual must make repeated size-ups to take account of the changed situation. Serious danger to the individual only occurs when, either through some change in the situation which he has not observed or some lapse in his mental size-up, the picture in his mind becomes incorrect."

"In the design of substations or any structure or equipment," Mr. Dean adds, "the natural barriers against accidents should be so obvious as to challenge any lapse in mental 'size-up' which might put the men working in a precarious position, or the design should be such that it is impossible for him to get in such a dangerous position."

In considering Mr. Dean's statement it should perhaps be recalled that considerable progress in accident reduction in the manufacturing industries has come from the provision of safety guards and allied devices which, in many instances, make it virtually impossible for the worker to become involved in an accident. The same principle has, of course, been applied in the system of interlocking switches in the electric industry which simultaneously contribute to the avoidance of both errors and accidents.

Where safety guards cannot be built into the design it seems a psychologically sound procedure to provide something in the way of vivid "barriers" or other devices which will help arouse the active attention of the operator in sizing up the situation in order to avoid the danger of accidents or errors. Although the latter are not specifically mentioned in the letter just quoted it is apparent that these must also be considered because of the naturally close relation existing among "precarious conditions," accidents and errors in the electric substation.

In this paper are presented a few psychological principles which, in the opinion of the author, merit consideration in

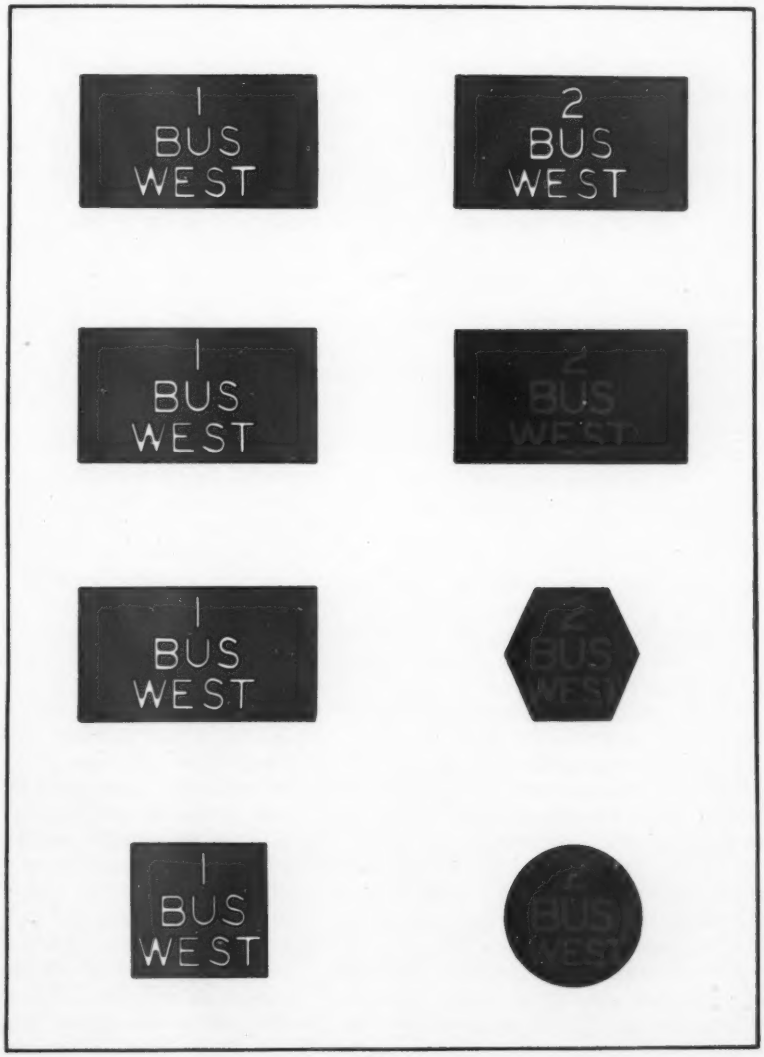


Fig. 1

arriving at modifications in substation design and installation with a view of decreasing liability to accidents and errors in substation operation.* Essentially the paper represents an attempt to apply to this problem certain principles of attention which have been developed in studies, by the psychologist, of similar problems in other fields.

The Effect of Size Upon Attention

Attention may be defined as a preliminary adjustment of the human machine which will enable it to deal with a problem or situation more effectively. Laboratory studies have demonstrated what must already be obvious to most of us—that the size of an object has an important bearing upon the arousal of active attention. As a matter of fact, from such studies it has been possible to formulate a law, known as the "Square Root Law of Effect," which gives the effect upon attention of given differences in size.

In promoting highway safety this knowledge is being capitalized upon by the use of signs of different sizes graded in relation to the magnitude of the danger approached by the motorist. In some places, for example, it is the policy to employ a succession of signs of increasing size, the ultimate or last one at the point of danger being proportional to the immediate hazard. So, for example, at a distance of 800 feet from the point of danger, there may be a small sign properly worded to indicate approaching danger; at 700 feet a little larger one, and so on, until immediately before the danger spot itself a very large sign is placed. This arrangement serves to create an increasingly greater drag upon the attention of the motorist as the danger point is reached.

It seems reasonable to believe that this *principle of size* may find an application in substation design. Pull buttons, indicating lights, switches, etc., on panels might perhaps be graded in size so as to bring into prominent relief and more easily into the center of attention those particular items of equipment to which crucial significance or hazard is attached. Certainly, in identifying equipment, the size of the target or marker used should be in relation to the hazard to personal safety or accuracy of operation presented in handling the equipment. The application of this principle might mean, in terms of current system practice, that the size of the marker indicating No. 1 and No. 2 Bus, respectively, would be considerably increased; that the targets identifying compartments containing circuit breakers and oil switches would be made larger than they now are; that, in general, an order of magnitude of identifying devices would be established having a direct relation to the importance of the equipment identified.

"Isolation" as an Aid in "Sizing Up" the Situation

Allied with the factor of size in attracting and holding attention is that of *isolation*. In studying the effect of advertising copy, for example, it has been found that the use of a white border to "set-off" an advertisement, that is to isolate it from surrounding copy, may increase the attention value of the advertisement by as much as 100 per cent.

This finding may find ready application in substation design. Hazardous equipment can actually be "set off" or physically isolated from other units as an aid in attracting attention to it as the operator "sizes up" the situation. On the panel, switches, indicating lights, instruments and so on which merit special attention in avoiding both accidents and errors can be isolated by painting the item of equipment to contrast with the board, or by the simple device of a colored border. If a superfluity of color on the board is to be avoided, the equally simple device of raising or indenting the surfaces bordering upon the item of equipment to be isolated can be employed.

Meaningful Associations with Shape

My observations in substations suggest that there has been a failure to capitalize upon differences in *form* or *shape* as a way of keeping an operator accurately oriented with respect to equipment under his charge. The problem here is that of establishing meaningful associations between certain types of equipment or certain situations and particular forms.

This principle has to some extent been applied in highway safety. For example, in some states, an octagonally shaped sign invariably means extreme danger. The same principle might be applied in the substation, particularly in marking equipment. On the Philadelphia Electric Company System, for instance, it is the practice to identify different buses with markers of the same size and shape, labeled No. 1 Bus and No. 2 Bus, respectively, approximately as illustrated by the figures at the top of Figure 1.

It is suggested that the danger of confusing buses, with all the hazards attached thereto, could be more easily avoided if markers of different shapes were used in identifying the buses, so that, for example, Bus No. 1 would invariably, in the mind of the operator, be the bus with the square marker, and Bus No. 2 that with the octagonal or perhaps circular marker. With differences in the shapes of markers could also be combined differences in color, so that Bus No. 1 would invariably be thought of as bus with the red and white square marker, and Bus No. 2 as that with the octagonal or circular yellow** and black marker. How attention is facilitated through this simple device appears clearly, I believe, in Figure 1 where different markers of the type described have been drawn in pairs for observation.

The use of differences in form need not be limited to markers alone. For example, on the Philadelphia Electric Company System—at least in some of the stations—indicating lights on 13,200 volt sectionalizing disconnect panels are shaped differently than indicating lights on other panels. This represents a sound application of the *principle of form in attention*. Unfortunately, in the case cited, the difference in the shapes of the two kinds of indicating lights is not sufficiently great to be easily perceptible. However, it would be a small matter to substitute for the octagonal or many-faceted indicating light used on the 13,200 volt sectionalizing disconnect panels, triangular or other shaped lights which would be in clear contrast with circular indicating lights on other panels and therefore more useful to the operator in the process of sizing up the situation. There must be numerous other places, possibly in the construction of equipment as well as in the planning of detail, where this principle of form could be applied.

Directional Indicating Lights

Paralleling the factor of difference in form is the effect of differences in direction. One method of attracting and directing attention is to use lines or bars which have a directional aspect. In advertising, the reader's attention is forced into the desired direction through the use of arrows and other devices. In decreasing accidents on the highway, the same device is frequently employed, curved arrows or other types of markers being used as aids in guiding the driver in the safe direction or in pointing out the location of potential hazards.

The *principle of direction,* I suspect, would find its most useful application in

*Although this paper is devoted specifically to substation design, the principles and suggestions outlined apply equally well to generating station design and perhaps to electrical equipment problems in other units of the industry.

**Reproduced herein as green.

the substitution of illuminated, suitably colored bars for the round indicating lights which are almost universally employed on switchboard panels today. In the construction of switchboard panels it is common practice to depend solely upon the color of identically shaped indicating light, generally red and green, to indicate the set-up as the operator sizes up the situation before proceeding with his work. The effectiveness of the indication, from the viewpoint of attracting and controlling attention, could be considerably improved if a direction clue were added to that of color.

If this were done, an *illuminated red bar in line with the bus* might be chosen as the universal symbol for a closed breaker; an *illuminated green bar at right angles to the bus* as the symbol for an open breaker. It might also be desirable and possible to provide an intermediate position in the form of a diagonal bar (with or without illumination or color) to indicate a breaker that needs to be opened or closed. Perhaps the effectiveness of the illuminated colored bar could be increased if a discontinuously instead of solidly lighted bar were used.

A glance at Figure 2 will perhaps furnish some subjective evidence of the relative attention value of differently colored lights of the same shape as compared with illuminated, distinctively colored bars (continuous and discontinuous) lying on different planes.

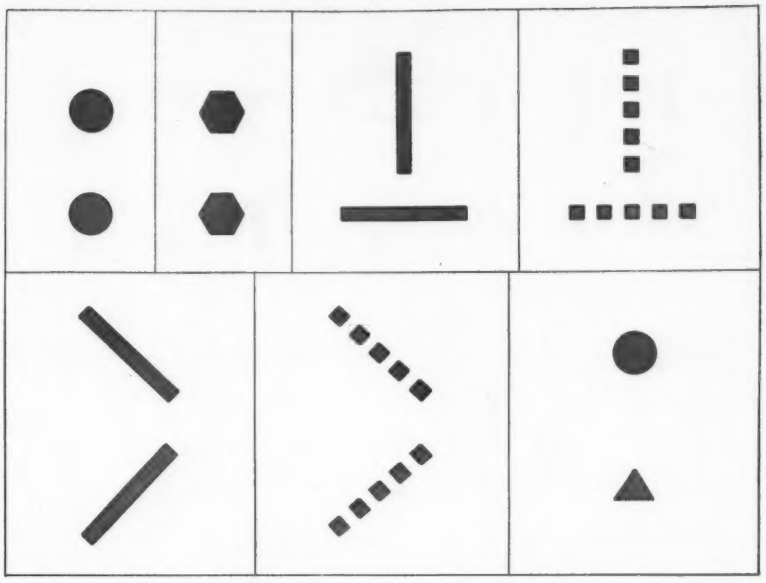


Fig. 2

Illustrations from the Substation

Possibilities in the way of practical applications of these suggestions are illustrated in Figures 3 to 7, inclusive. These furnish specific examples prepared at my request by L. E. Goodenough, Supervisor of the Operations Department School of the Philadelphia Electric Company. Figure 3 shows a comparatively simple control board for a transformer substation. The top section of the board shows the mimic buses and the twin pull button type of control switches for the transmission lines, transformers and bus sectionalizing oil circuit breakers. In the lower part the low tension breakers of the transformers are shown. The familiar red and green lights indicate the positions of the breakers.

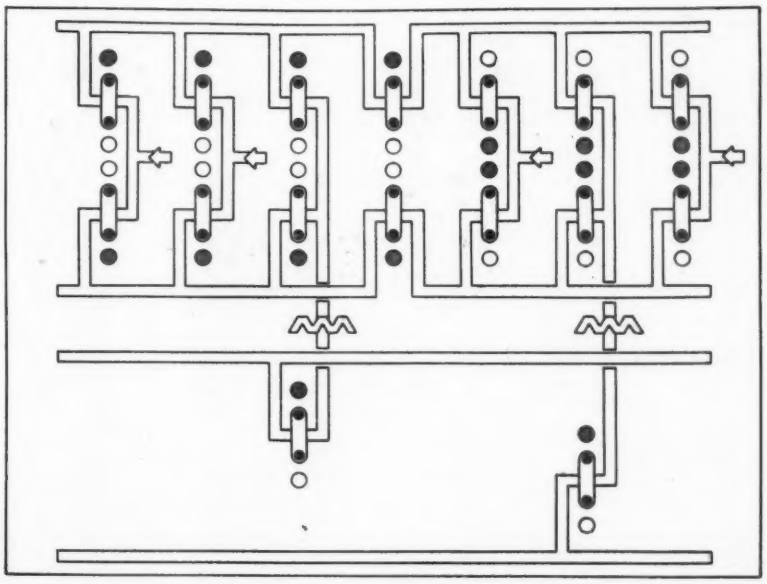


Fig. 3

While this is a relatively simple station, note the greater clarity of outline, the greater ease of visualizing the switching in the lay-out illustrated in Figure 4. This involves, incidentally, the use of a new type of control switch described in futher detail below. The indicating light is in the handle of the control switch and changes from red to green and vice versa for the appropriate switch position. In addition, it shows a *green bar at right angles* to the miniature bus when the breaker is open and a *red bar in line with the miniature bus* when the breaker is closed.

Figure 5 shows a type of lay-out which is being used with increasing frequency—a modified form of ring-bus. It is shown as it is generally installed initially. The top bus is sectionalized in the middle and the top and bottom buses may be tied together by the bus tie switch at the extreme right. Again the twin-pull button type of control switch is shown. The use of the bus sectionalizing and bus tie breakers has added to the complexity of the switching and the operator has greater need for complete visualization of his switching moves. In the diagram shown, the closing of the bus sectionalizing switch in error may cause a tripping and loss of load. Any operating man can see other possibilities for error in this arrangement, especially in time of emergency.

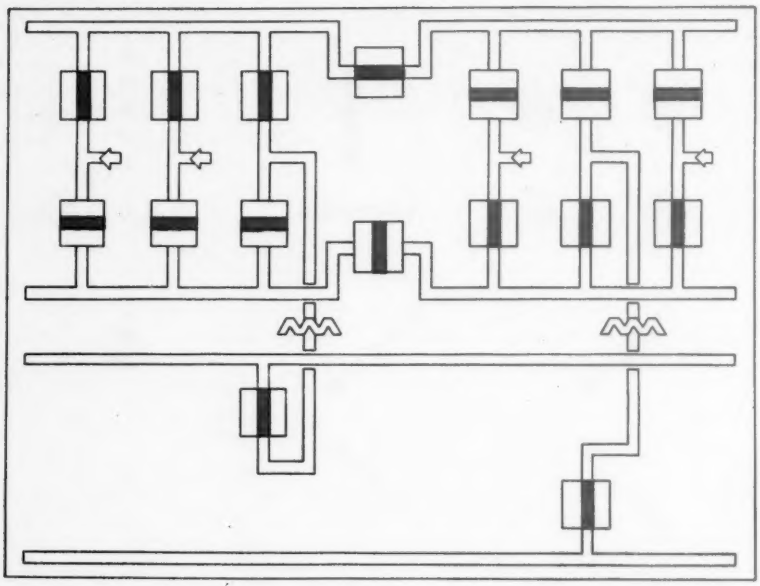


Fig. 4

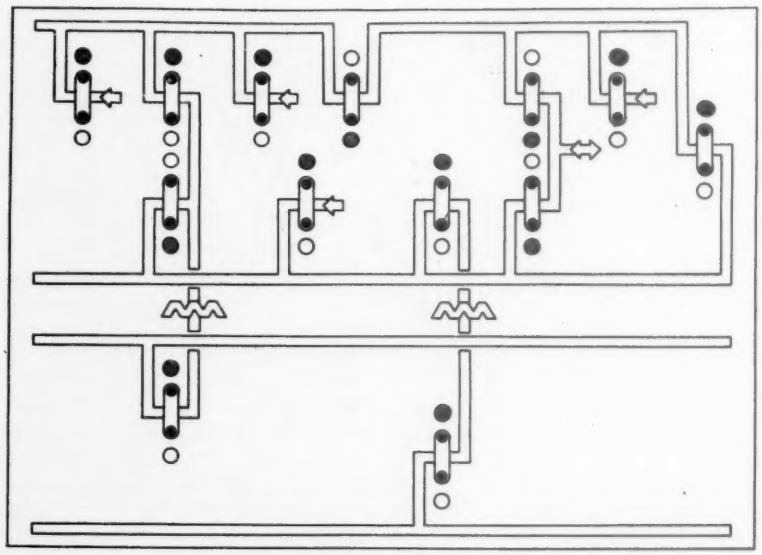


Fig. 5

Figure 6 shows a complete lay-out of the bus and associated oil circuit breaker controls embodying the recommended new type indicating device. Again, in comparison with that shown in Figure 5, the simplicity of this lay-out is apparent. My secretary, upon seeing these diagrams, said the new lay-out was "streamlined." And so it is—streamlined—for an accurate visual check of the switching job at hand. In this figure there is also indicated the possibility of bringing into play the principle of *form* by, for example, surrounding each sectionalizing and bus-tie switch with, let us say, a triangular or circular device to contrast with other switches on the board.

In Figure 7 is shown a preliminary sketch of a device for the indication and operation of an oil circuit breaker in accordance with proposals made in this paper. The new feature of this device is the use of a translucent material in the T-shaped handle. On the back of the panel, or possibly in the hollow leg of the T, are the red and green indicating lamps, controlled in the usual way by the auxiliary switches on the breaker mechanism. A spring device, similar to the one used in the twin pull button control switch, keeps the closing or tripping circuit open until the T-shaped handle is pulled by the operator.

Another advantage of this device is that the control switch can be used to "try-out" a switching job, without actually doing it. If, for example, the operator was about to close an oil circuit breaker on one of the lines now open; he could turn the hollow shaped handle, now colored green, to a position in line with the diagram outline. Then, looking over his board, he can check to make sure that the operation is the correct one to perform. When he is satisfied that it is, he pulls the T-shaped handle just as he would the familiar pull button switch, and the oil circuit breaker operates. The indicating light in the stem of the handle changes from green to red while the position of the bar turns from right angles to the bus to one in line with it. The operator leaves the handle in the position to show a continuous red line to the bus.

An important feature of this device is that it provides a visual check on the oil circuit breakers so that the effect of the most complex switching operation can be seen readily by the operator. His attention is attracted by the red bar in line with the bus, and the green bar at right angles to it. These give him direction as well as color—and become associated with the oil circuit breaker positions. His attention is further stimulated by the "try-out" principle which, in addition, allows him to check the complete operation without actually doing it. This feature will be further discussed below.

Visual Aids in Avoiding Danger

In the illustrations use has been made of a mimic bus. I understand that, although these are not used to any extent on the Philadelphia Electric Company System, mimic buses are used widely on other systems. In passing, it may be of interest to note that from the viewpoint of the human machine there seems real justification in employing the mimic bus as an aid to the operator in "sizing-up" the situation. Experiments show that attention remains better adjusted if the different parts of the object attended to are related to each other in such a way that attention may skip to one part or another easily. This *unity* may be achieved by a set-up such as that repre-

sented by a mimic bus in which all the parts of the bus form a general design that has meaning and significance to the operator.

Accommodation of Attention

There is time to touch only briefly upon two or three other factors which deserve consideration in substation design. One of these is technically known as *accommodation of attention.* This term means that if a person is prepared for an event before it occurs he will receive a more complete and detailed impression of it and will respond more quickly and more accurately to this impression.

It is interesting to note that, without perhaps a formal recognition of this principle of accommodation of attention, engineers have actually taken advantage of it in the design and construction of substations. This appears, for example, in the requirement, built into equipment, that the operator manipulate a control switch, such as certain types of lever switches, before proceeding with the main operation. This preliminary or "setting" operation definitely tends to attract attention toward the main operation to be performed and to hold attention on that operation while it is being performed.

The findings of the psychological laboratory favor a wide extension of this procedure. At the same time, its effectiveness could probably be increased by the recognition of certain factors and principles which develop from experiments in the psychological laboratory.

Such experiments show, for example, that *accommodation of attention* can be facilitated by *directing* both "postural set" and attention toward a particular object or occurrence. This is illustrated in the "complication experiment." This involves reaction to an arm which moves rapidly along an arc. The apparatus is adjusted so that a bell sounds as the arm passes a particular point on the arc. The subject attempts to state where the pointer is at the time that the bell sounds. It has been found that if his attention is directed toward the pointer the effect of the bell as a conscious experience is delayed so that, in reporting, the subject places the pointer beyond the spot at which it was when the bell sounded. In other words, his attention is held at the pointer by the postural set adopted at the beginning of the experiment, so that he locates the pointer beyond the actual place at which the sound occurred. On the other hand, if the subject's attention is directed primarily toward the bell, he seems to perceive the

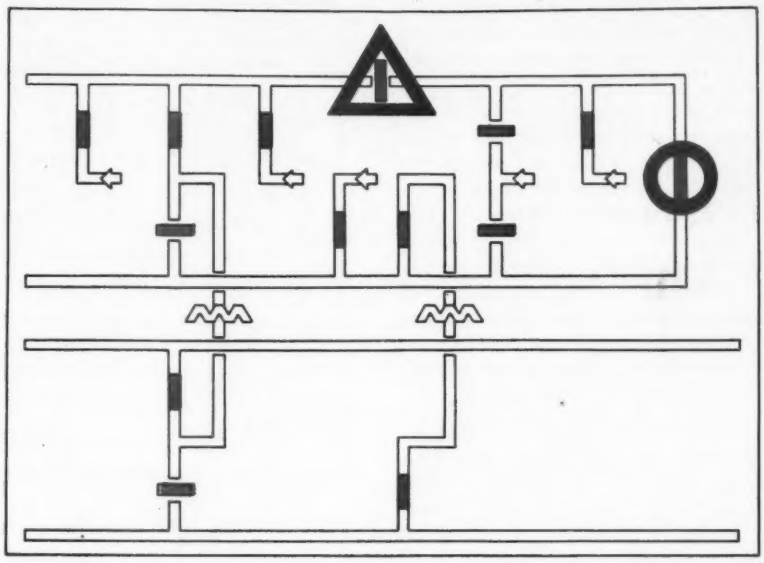


Fig. 6

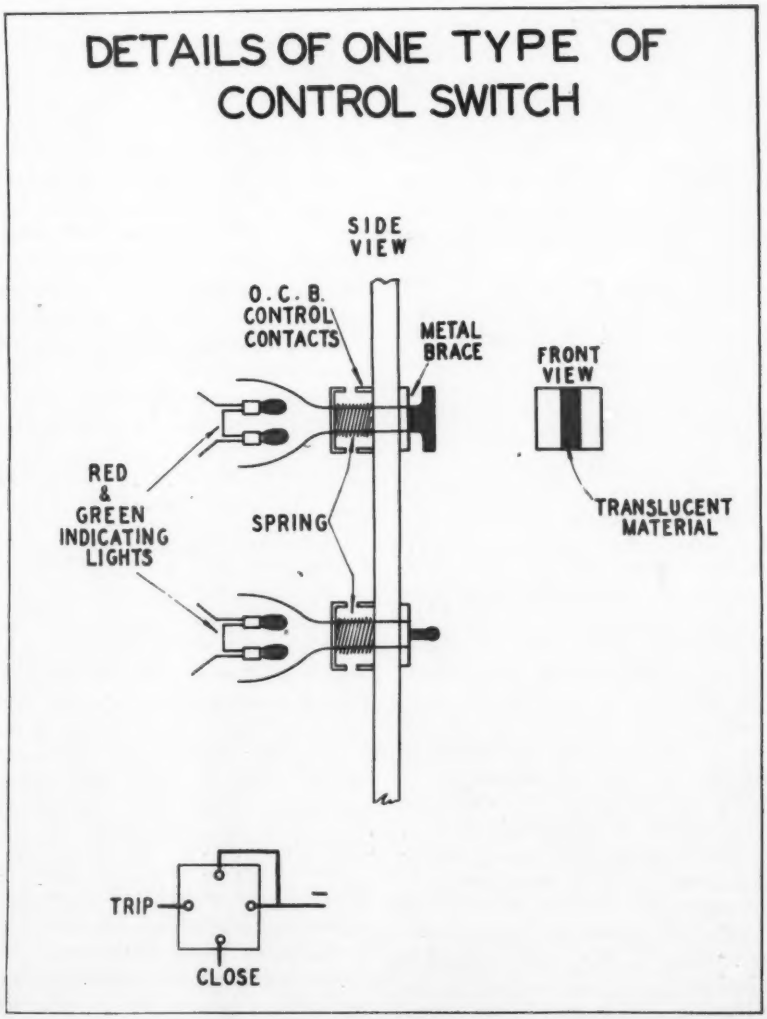


Fig. 7

sound comparatively earlier, that is, he places the pointer in advance of the spot it actually reached when the bell sounded.

Such findings might be applied in substation design by utilizing the preliminary operations to indicate exactly the nature or direction of the major operation which is to follow immediately. This has been done in preparing the device illustrated in Figure 7 where the preliminary operation of the control switch (T-shaped handle) helps to direct and hold the attention of the operator on the next operation by indicating exactly what will happen when it is performed.

Other Aids in Sizing-Up a Situation

Both everyday observation and experimental studies in the laboratory show that *motion* is a potent factor in attracting attention. Attention is easily attracted toward moving stimuli of all kinds. Motion has another advantage in that the periphery of vision is much more sensitive to moving than to stationary stimuli. In simpler terms, attention is more easily attracted to a moving stimulus seen out of the "corner of the eye" than to a stationary object or stimulus. A common example of this is to be found in the fact that we notice moving automobiles at the side of us as we drive along while paying little attention to stationary ones.

This principle of motion has been widely applied as a safety device. Stationary stop lights on the rear of automobiles are being supplanted by flashing lights. In the electric industry, the open manhole is today surrounded by intermittent flashing lights and not by the stationary lights used in earlier years. I suspect that there is room for the application of this principle in substation design and construction. For example, on equipment over which the operator is liable to trip it might be possible, through the use of photoelectric cells, to arrange for a light to flash as the operator approaches, in much the same way as a light flashes to warn pedestrians and motorists of an approaching train. I have noticed that stationary lights are used to identify compartments carrying live equipment. A flashing light might serve a much more useful purpose in this connection. On the switchboard panel itself flashing lights, instead of stationary lights, might be brought into operation in connection with the manipulation of key switches or the handling of particularly hazardous equipment.

There are numerous other factors affecting human response which deserve serious consideration by the engineer. For example, *discontinuous lines or areas* represent better "attention-getting" devices than continuous lines. This means that cross-hatched lines or areas can be used more effectively in identifying or setting off equipment than can solid lines or areas of a single color. This principle has been widely applied in marking highways and undoubtedly has application in the substations. The use of such cross-hatching will tend to break up the pleasant homogeneity of neutral color now characterizing most substations, but the loss in aesthetic values will be more than compensated for by the gain in safety.

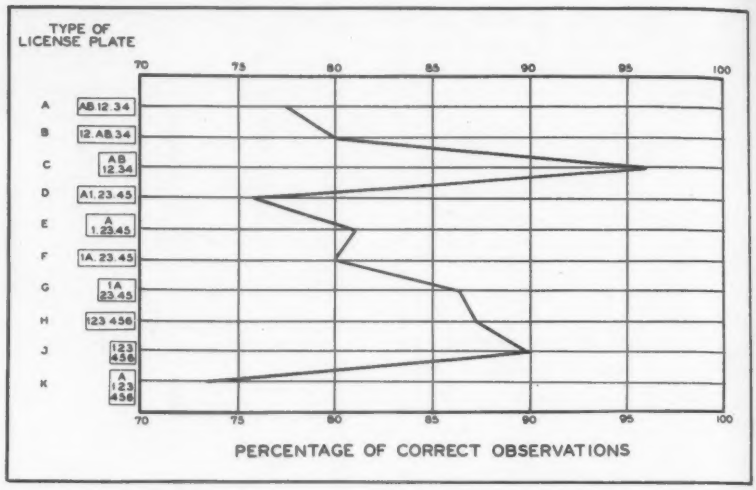


Fig. 8

Probably too little attention has been given to the relative *legibility of contrasting colors* used in markers and targets. In general, numerous investigations show that the greatest legibility occurs when there is a marked contrast in brightness between type and background. In other words, it is not so much the amount of color, rather the way in which it is employed, that is important from the standpoint of attention. Numerous studies of legibility of various color combinations are available upon which the engineer can draw in designing markers of all kinds and in using contrast effects on panels and elsewhere.

The legibility of various kinds of *prints* or *type* used in markers, and possibly also on instruments deserves greater consideration, since experiments have shown that certain types are much more legible than others. So, for example, *Cheltenham* represents one of the most legible types, while the *American Typewriter* represents one of the least legible types.

The arrangement of numbers and letters on markers and targets also deserves consideration. The importance of this appears, for example, in a French study where the arrangement of six digits and letters marked C on Figure 8 was read accurately 96 per cent of the time under standard conditions, as contrasted with 76 per cent accuracy for the arrangement of six units in the form D, and an accuracy of 72 per cent when seven discrete units are arranged in the form marked K in this figure.

As suggested in the introduction, this paper has largely been devoted to the presentation of facts and principles derived from studies in other fields which appear to have a bearing on the substation. From a consideration of these, certain assumptions and recommendations have been formulated with respect to possible modifications of substation equipment design and installation in the interest of safety and accuracy in operation. In addition to whatever specific merit these recommendations may have, their presentation may serve a useful purpose in indicating both the need and opportunity for joint research by engineers and psychologists on problems involving the co-ordination of man and machine, such as are discussed in this paper. It seems highly probable that such co-operative research can lead to important contributions toward the prevention of accidents and errors in the electric industry.

Property-Life Insurance

What Is It and What Are Its Possible or Probable Applications in the Field of Public Utilities?

By Bernard S. Rodey, Jr.
Chairman, General Accounting Committee, E. E. I.

At the outset let it be clearly understood that I know little about Property-Life Insurance except what I have recently read on the subject in books, papers, and other material furnished through the kindness of G. M. Wunderlich, LL.D. Those who find the subject of interest are referred to a forthcoming book by Hans Heymann, Ph.D., to be published shortly by Harper & Brothers. A short bibliography of books and papers issued in this country accompanies this review.

This brief review is undertaken because it appears to me that the principles underlying Property-Life Insurance, now in its pioneering stage of development in this country, may ultimately have some bearing on our property accounting and our concepts of dealing with property maintenance and replacements in the Public Utility field.

Two important accounting factors are particularly affected, namely, depreciation and planned amortization of investment due to obsolescence.

What is Property-Life Insurance?

We learn from Dr. Heymann that although this country is more insurance-minded than any other, as shown by statistics, there still remains a substantial gap, namely, Property-Life Insurance. We know that life insurance is intended to replace the earning capacity of the insured. But, states Dr. Heymann, "we have failed so far to concede that physical objects may 'die' just as surely as human beings." That event will have occurred when the cost of repairs is equal to, or exceeds, the cost of building a new property. While we have provided for the restoration of such objects which have been damaged through accidents of all kinds, we have on the whole neglected to provide for their replacement when they have reached the point where they have no real economic justification. Buildings, plants and machinery, as well as ships and other means of transportation, have been stressed as being particularly desirable fields for Property-Life Insurance.

The actuarial "technique" or basis for Property-Life Insurance is stated to be not unlike that of human life insurance; one having to do with lives of human beings, the other with lives of structures and other items of physical property. However, it is emphasized that Property-Life Insurance is by no means life insurance, "that by law and by its own nature Property-Life Insurance is pure property and pure risk insurance in all its characteristics and has a technique all of its own." It is interesting to note that the actuarial basis includes not only the probable life of structures and machinery but also the probable frequency of damages from depreciation which are to be anticipated. Contracts are limited to a minimum of ten years and a maximum of one hundred years.

Property-Life Insurance and Obsolescence

Apparently a sharp line is drawn between depreciation due to "wear and tear and the action of the elements" and depreciation due to obsolescence. In his book, Dr. Heymann emphatically asserts that his plan does not insure against obsolescence. "Property - Life Insurance must eschew any insurance against obsolescence, for the simple reason that obsolescence is an unpredictable hazard." But in *Builders' Forum* (March, 1937, on page 18) the same author states, in an *editorial comment* on an article entitled *"Obsolescence of Land Value in Relation to Building Values,"* that "The answer to obsolescence in building values is life insurance on the buildings and/or life insurance on the machinery and equipment." The explanation to this apparent inconsistency is that the insured may draw on his policy up to the amount of the accumulative damage reserve—in the form of a loan. This is in effect an indirect coverage of obsolescence. The probable lives determined appear in reality to budget or plan the economic life of the object, although undoubtedly based on as many reliable data as were available to the actuaries.

As with life insurance, time and experience will undoubtedly permit greater accuracy in forecasting probabilities in this field.

Property-Life Insurance in Practice

The idea of Property-Life Insurance was practically introduced in the United States apparently late in the year 1936. At the present time legislation authorizing this new form of insurance has been enacted in New York and Illinois.

The Property-Life Insurance Company of America, which has been incorporated under the laws of the State of New York, will insure, according to Leonard M. Gardner, counsel for the New York State Insurance Department, any income-producing property.

Mr. Gardner illustrates by a concrete example what the company intends to offer, assuming an application for property-life insurance on a building costing $100,000:

"An engineer for the company will examine the building, the materials will be carefully tested by a chemical laboratory and if it is estimated that the building will last thirty years and the building is insured for $100,000 the premium charged will be $2,-975.00 yearly, which will insure against damage caused by

1. Leakage in the roofing.
2. Dry rot.
3. Cracks in wall or ceiling foundations or in supporting pillars.
4. Bursting of pipes if occurring because of natural wear and tear.
5. Dampness of rooms designated for the permanent habitation of human beings.
6. Subsoil water.
7. Settling of parts of building.
8. And on machinery and mechanical and electrical equipment of every kind against total or partial loss or damage, including loss of use, by reason of total or partial depreciation and deterioration.

"In addition, and probably most important of all, whatever remains of the insured amount of $100,000 after deduction of all earlier indemnities would be provided at the end of thirty years to replace the building. If the life of the building, and therefore the policy term is sixty years and the insured amount $100,000, the premium would be $1,300 yearly.

"If the owner of the imaginary $100,000 building had a mortgage of $50,000 the mortgagee could protect himself by an as-

signment of all policy rights executed by the owner as mortgagor in favor of the mortgagee. The latter thus enjoys an additional security and would be protected against the damages of depreciation."

In the example given, assuming a thirty-year life, with an annual premium on a $100,000 building of $2,975, the total amount paid in would be $89,250. Deducting therefrom 20 per cent anticipated dividends, amounting to $17,850, would put the net cost of $71,400, not considering the payments of indemnities for damages during the term of insurance.

Hazards Not Covered

"Following the practice in fire-insurance policies, certain hazards are specifically excluded, such as the following:

1. Force majeure; i.e., earthquake, tornado, rock-slide, subsidence of the earth, floods, fire, lightning, explosion, windstorm and the like, but not including the gradual effect of weather due to rain, snow, heat of the sun, and cold.
2. Invasion, insurrection, riot, civil war or commotion or military or usurped power, or by order of any civil authority.
3. Theft.
4. Flaws and deficiencies which existed at the time the policy was issued and which the insured did know or should have known.
5. Fault or errors of commission or omission of a contractor for which he is legally or contractually responsible.
6. Violation of the insured's duty to prevent structural damages where such violation is intentional on the part of the insured, or results from his gross negligence.
7. Willful or intentional act or acts, or gross negligence, of the insured or of third persons."

What may be the ultimate development of Property-Life Insurance appears problematic, particularly in the Utility Field. Questions that come to mind refer to the borderline between maintenance and depreciation, between deterioration and obsolescence. According to Dr. Heymann, "during the insured life term, all vitally important repairs are covered (partial, premature losses)." Does this include upkeep (as is indicated by R. B. Shoemaker, Supt. of Construction, The Equitable Life Assurance Society)? The answer is stated to be yes—provided the policy is reinstated after each such damage recovery to the original amount of its face value. And if so, will there be anything left when the building finally must be replaced? Dr. Heymann reasons that "since the interim damages will of necessity be deducted from the maturity payment, there will be a definite incentive for the insured to refrain from excessive damage claims during the term of the policy." It remains to be seen whether that optimism is justified.

Another interesting question refers to the relation between depreciation reserve requirements as established by the Uniform Systems of Accounts, and the proposed Property-Life Insurance. Surely, there is much food for thought in this subject and it appears to offer an inviting field for study by Accountants, Engineers and others interested in Economics of the Utility Business.

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Edison Electric Institute Medal for Resuscitation Now Available to Qualifying Employees of All Companies

At a meeting of the Operating Committee of the Edison Electric Institute held November 15, 1933, authorization was given for the establishment of a medal for presentation to employees of Member Companies, who through the use of the Prone Pressure Method have successfully resuscitated individuals from electric shock. As stated in the plans for award of the Edison Electric Institute Medal: "The medal may be awarded to employees of Member Companies of the Edison Electric Institute for meritorious cases of successful resuscitation from electric shock by the Prone Pressure Method."

Since the medal has been made available, there have been 79 awards made to employees of Member Companies who have been instrumental in saving a considerable number of lives from electrical shock.

With the hope of further stimulating interest in the training of employees in the Prone Pressure Method of Artificial Respiration, the Operating Committee of the Institute at its meeting on March 8, 1939, authorized the making of the medal available for award to employees of any privately owned and operated electric light or power company in the United States, regardless of membership in the Institute, who successfully resuscitates an individual from electric shock.

Organizations, by the establishment of medals for award in resuscitation cases, are endeavoring to keep before public utility and industrial companies the value of training of men in artificial respiration. For those who have been privileged to examine into the details of these cases, it has been quite apparent that to save life after electric shock, drowning or gas poisoning, it is absolutely essential that trained persons be immediately available.

It is the hope of the Edison Electric Institute by enlarging the basis of this award that more interest will be shown in the training and as a result of this training, more lives will be saved.

Customer Benefits Prize Paper

"A Letter to Charlie": in re Power

By John H. Campbell
Consumers Power Company, Lansing, Mich.

A prize-winning paper in the recent Industrial and Commercial Customer Benefits Contest

December 8, 1939

Mr. Charles Quandary,
Acme Corporation,
City.

Dear Charlie:

Last Wednesday at Rotary Luncheon you asked me why I decided to discontinue making my own power at Simplex in favor of buying it from the Power Company. I gathered that you yourself are in the process of mentally appraising the various factors involved as they bear on your own business. My answer was rather brief the other day and it has occurred to me that possibly it might be to our mutual advantage if I were to spend a couple of hours jotting down the various points which led me to the conviction that purchased power puts private generation behind the eight ball. You see, the Simplex Board of Directors will probably ask me the same question any day now.

You and I are both faced with the problems of management which give us a common viewpoint in approaching a subject of this nature. We are both faced with the necessity of earning a decent profit or losing our jobs. I'm sure that you'll agree that this is no sinecure in these times of increased basic costs and short-circuited distribution of consumer goods. Consequently, every controllable item of expense is logically open to question, as always. I must confess that the cost of running our own private power plant did not immediately appear to me in its true perspective until a representative of the Power Company broke it down for my benefit. My error was simply a sin of omission. I found that I had been making the mistake of concentrating only on our bare power operating costs to the exclusion of other indirect expenses directly attributable to a private plant which are paid out of precisely the same pocket. Perhaps you are doing the same thing, Charlie.

The first question I asked myself was: "How important a consideration is this item of power?" Five per cent of our total picture and thus certainly worthy of some thought. Furthermore, the entire plant is completely dependent on power. When it fails, labor, superintendence, production and maintenance all come to an abrupt halt. Next—"Do we have all the pertinent facts regarding our present power costs at our finger-tips?" I thought so but two hours' conversation with the utility's industrial man made me wonder. I know now that a generous portion of the problem was systematically escaping my attention, disguised in the form of supposedly unavoidable fixed charges on the factory as a whole. Furthermore, a host of intangible factors, difficult to evaluate in terms of cash, came to the surface simply because I had never encountered them on a balance sheet.

We were faced with an impending shortage in power supply a few months ago. For several long lean years we had had ample capacity with much too ample overhead—but the business outlook indicated that the return to normal was slowly approaching. With fair assurance of a receptive market I figured that it was time to plan for materially expanded production on certain of our items. It gave me a bump to find that our power house couldn't "lay it on the line." Right here you get a solar plexus punch in the vicinity of your engine room. A private generating plant lacks flexibility. If manufacturing activity slumps you float along with light load and poor economies. When the bell rings for action you are apt to be caught short for capacity, just as I was. Then you either bury some carefully nursed quick assets in power machinery or else you start looking around. If you buy the machinery you find you've depleted your working capital to the point where you can't make quick changes in technique designed to meet markets and competitors—in other words, your foot-work is bad. That spells K.O. these days.

If you are inclined to minimize this matter of flexibility, pause for a moment and consider these points. What is the economic life of a private plant? The physical life may well be fifteen to twenty-five years, depending on the type but I am convinced that this is apt to be a red herring. The economic life is the proper thing to consider. We've already touched on the hazards of capacity and the possible freeze-up of working capital. Changes in your business five years from now (which you cannot foresee) may force you to sink some more money in power equipment, perhaps in order to protect your past investment. Obsolescence, while not a direct threat, nevertheless lurks continually in your engine room. You can't halt new developments and inventions which leave you antiquated and out of step.

Once you install that new unit you become a gambler. You gamble in the fuel market which naturally fluctuates with supply and demand. No one will endeavor to guarantee fuel oil or coal prices a year from now. This uncertainty surrounding a basic operating cost introduces a wholly unsatisfactory variable in preparing estimates and budgets. And don't forget that brand, spanking new units get older every day—and their physical efficiency gradually declines, even as you and I. So don't bank too heavily on initial operating figures. They will eventually need a cane, too. I've learned from experience that they seldom meet expectations anyhow, even when the unit is a prime young buck. There is a marked difference between the man-

ufacturer's block test with ideal load and the conditions under which you must operate. Figure the actual economic life at four years and you'll hit it about on the nose. Can you amortize the investment in that space of time through savings? Production equipment in my plant has to justify itself within three years or I don't sign the order. Two out of three business men are as hard-boiled as I am, or more so, on equipment policy. You are too, Charlie. Well, power equipment is production equipment, isn't it? Can you make it pan out? If you can't, don't add a power plant to your worries. Labor and raw materials and competition will bleach your hair without any help from horsepower.

I have been rather abusive toward the engine room. What about the alternative? Let's sum up the points I've already made and see how buying your current fills the bill. First, Central Station service is flexible to the tune of I don't know how many thousand horsepower. If you want to add a block of needed power right now you simply add it. It's frying on the wires ready for use. If you have to slack off a bit for two or three months your fixed charges for power decrease in proportion. You don't load up with an overhead that only a receivership can soften. The fixed charges on added blocks of purchased demand are arranged on a scale of decreasing increment cost. If you have a heavy load period in your daily schedule you can shunt it into the Power Company's off-peak valley hours and get as much as 500% excess capacity without spending an additional dime for it. Contrast that with providing a unit big enough for peaks which proceeds to loaf on you for twenty hours per day! You'd fire a foreman if he handled his working force that way. Another interesting angle is the effect on working capital—it stays that way. Need I say more?

If you buy your power you can dismiss the future chance of sending some more assets down the drain after an obsolete investment. Obsolescence is always inescapable but you do succeed in breaking up its effect into small parcels which are much easier to manage. Purchased power takes the gamble out of power costs. Fuel costs, oil in your case, fluctuate widely but the long term trend is definitely up, as one would expect. Now, the trend in cost of Central Station energy is emphatically down at a fairly steady rate. What's more, it will continue that way because the utilities are continually expanding their market and improving their plant. The divergence in costs therefore widens as the years go by and the increased efficiencies built into new, relatively small private generating units cannot hope to compete with the economies progressively effected by the Central Stations. The Utility switchboard and delivery costs and the remarkable growth in the percentage of industrial motors driven with purchased power during the past forty years prove the point.

Let's look at some other phases of the question which, taken together, build up an impressive case against generating your own power. Utility service is much cleaner and cooler, doing away with the inevitable grease, oil, dirt and heat of the engine room. My new power source is quiet and vibrationless. The elimination of a highly potential fire hazard improves your over-all rating as an insurance risk. It goes without saying that purchased service is more convenient and reliable, starting at the throw of a switch and staying with you until the day's work is done. This feature is saving me real money by doing away with starting delays and emergency shut-downs of assorted sizes and causes. The bogey of a protracted shut-down for major repairs at the wrong time is gone. We had one break-down of 48 hours which cost us a $10,000 order with a nice margin simply because we failed to make the delivery dead-line. I doubt if we'll get a crack at that account again for some time to come. Our machinery use and occupancy insurance helped some, it is true but it didn't recapture the customer and our employees lost working time. Spoilage of material in storage because of power failure is not a factor with my company but it must stare you in the face day and night.

The safety angle with purchased service appeals to me. I feel that I have eliminated one more danger spot where someone might be injured or killed. Financially such an occurrence is covered by insurance but nobody wants to see such things happen.

Conversion to purchased power liberated enough floor space in my plant in production to offset 30 per cent of the cost of the change-over. I have been paying taxes and upkeep on that area but it was not returning one dime in productive work. Why don't you survey the space now occupied by your unit and auxiliaries and get an unpleasant surprise?

Central Station energy is tailor-made for my purposes. The frequency is stabilized and voltage regulation is what it ought to be. Somehow we never achieved that state of affairs when we operated on our own hook. Do you? Voltage variations formerly raised Cain with our motor speeds and the quality of the product therefore suffered. Spoilage has been reduced 30 per cent with an attendant saving.

The utility boys have helped me solve several problems which had plagued us for years, and some others we didn't know we had. They installed graphic meters on our machines which led to an improvement in the routing of our materials. They laid out changes in lighting on our assembly line which boosted production 20 per cent and did away with a bottle-neck. They showed me how to improve my power factor which resulted in a saving on the power bill and liberated some 30 per cent more copper capacity. They tipped me off to the possibilities of time lag fuses and showed me the first perfect color-matching unit I've ever seen in my life. They introduced me to the potentiality of photo-electric control. In short, they gave me practical engineering advice which didn't cost me a dime. True, I could have gotten the same dope from a consultant for a nice fat fee but the point is, I never had. I have a hunch you're in the same boat.

For the first time since we have set up shop we actually know what our power is costing us. The power bill, in one concise figure, gives us the answer. I'm firmly convinced that it is practically impossible to integrate all the cost factors of an isolated plant into one accurate total expense. Accounting has thus been simplified and considerably improved.

Insurance and taxes on our old plant equipment have been wiped out. Our labor cost has been substantially reduced, prime mover supervision having been eliminated. We operate at universally high efficiency regardless of load. Working conditions are better. The plant superintendent has 10 per cent more time to devote to production channels. The responsibility for continuity of service has been transferred to the ample steel shoulders of a sub-station.

The matter of income tax must not be overlooked in appraising a situation such as your own where construction is financed without interest-bearing obligation. As you know, Federal income tax regulations in this case allow as deduc-

(Continued on page 114)

Electrical Features in the Modernization of the Louisiana Steam Generating Station

By H. B. Wood

Chief Electrical Engineer, Stone & Webster Engineering Corporation

A paper presented at a meeting of the Electrical Equipment Committee, E.E.I., Buffalo, N. Y., Feb. 6-7, 1939

IN 1929 there was constructed at Baton Rouge the Louisiana Steam Generating Station of the Gulf States Utilities Company for furnishing process steam and electricity to industrial customers. The station was fully described in various technical journals*, but a brief resume may be helpful here.

The initial installation consisted of three 3600 rpm noncondensing turbine generators. The generators are rated 15,000 kw, 80% power factor, 13,800 volts, 60 cycles, with direct connected 250 volt exciters. There were also installed four Babcock & Wilcox straight tube cross drum boilers, each having a maximum steaming capacity of 350,000 lb per hour and a maximum working pressure of 670 lb per sq in. The boilers are designed for burning eight different types of fuels, such as natural gas, oil, sludge, acid tar, pulverized coke, and other by-products from a refinery. There is a double 13,800 volt bus to which outgoing feeders are connected with the "H" arrangement. To these main buses are connected, through selector oil circuit breakers, the generators and a 30,000 kva bank stepping up to 66 kv. Normally both buses are in service. In 1931 an additional boiler was added. The original turbines exhaust at approximately 140 lb gage, at which pressure steam is transmitted to industrial users.

A cross section of the plant is shown in Fig. 1. Fig. 4 is a photograph of the plant, and Fig. 5 is a photograph of the Turbine Room.

* *Southern Power Journal*, September, 1930. *Power Plant Engineering*, February 1, 1831.

1938 Extension

Since the construction of this plant there has developed a need, due to expanding industries, of not only additional steam but also additional electricity, part of the latter being required to be firm without process steam.

In 1938 the Gulf States Utilities Company started an expansion of this plant with the installation of two extraction type condensing steam turbines and two boilers. It is this extension and the resulting changes in the electrical features that this paper proposes to describe.

Type of Units

With the original installation of noncondensing units the electrical energy generated by process steam was in excess of the requirements of the industrial customers, the excess being absorbed by the Gulf States System. Since the original Louisiana Station was built, new industries have been located at

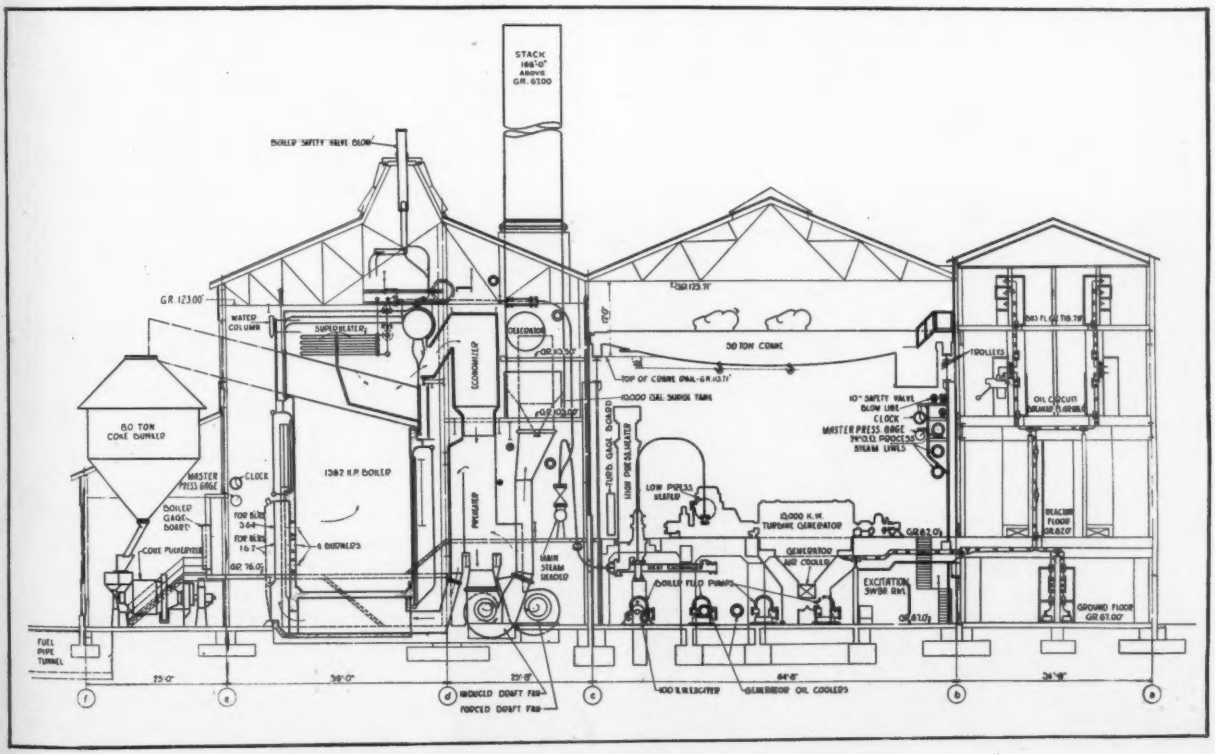


Fig. 1—Cross Section of the Louisiana Steam Generating Station

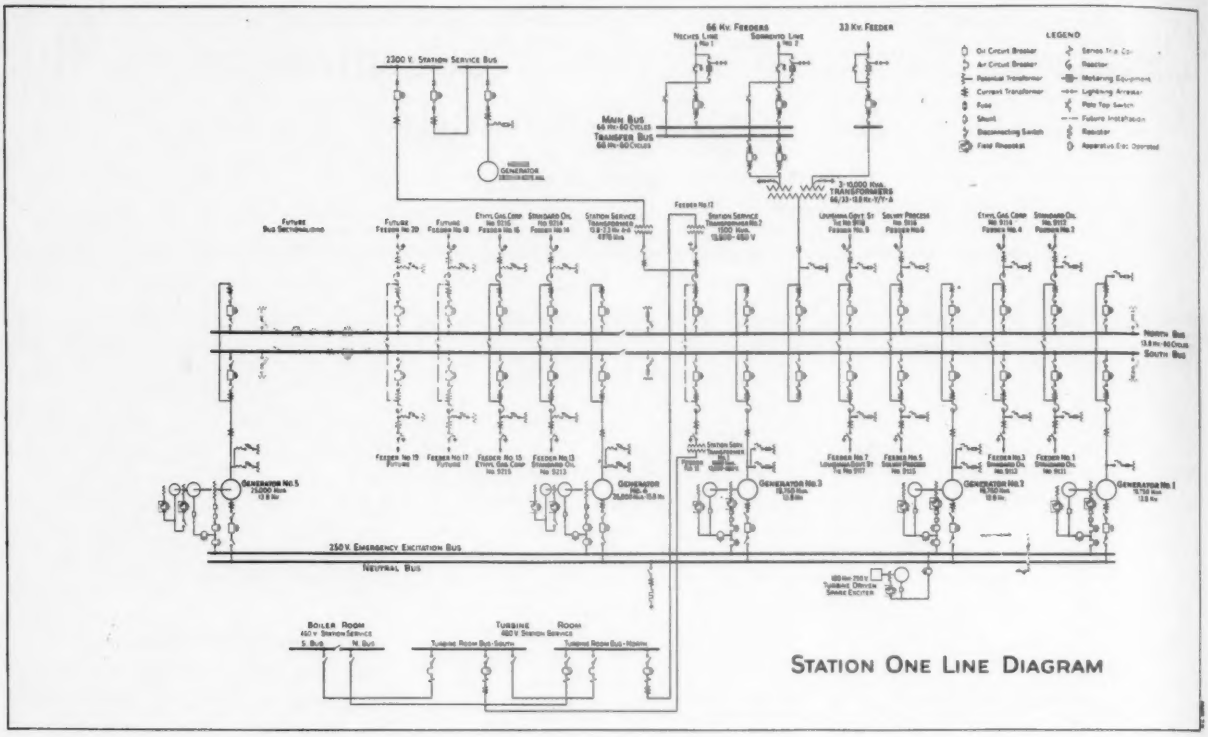

66 Kv. Feeders
33 Kv. Feeder
2300 V. Station Service Bus
Main Bus
Transfer Bus
LEGEND
Station Service Transformer No. 2
1500 Kva.
13,800 - 480 V
North Bus
South Bus
250 V. Emergency Excitation Bus
Neutral Bus
Boiler Room
Turbine Room
Station One Line Diagram

Fig. 2

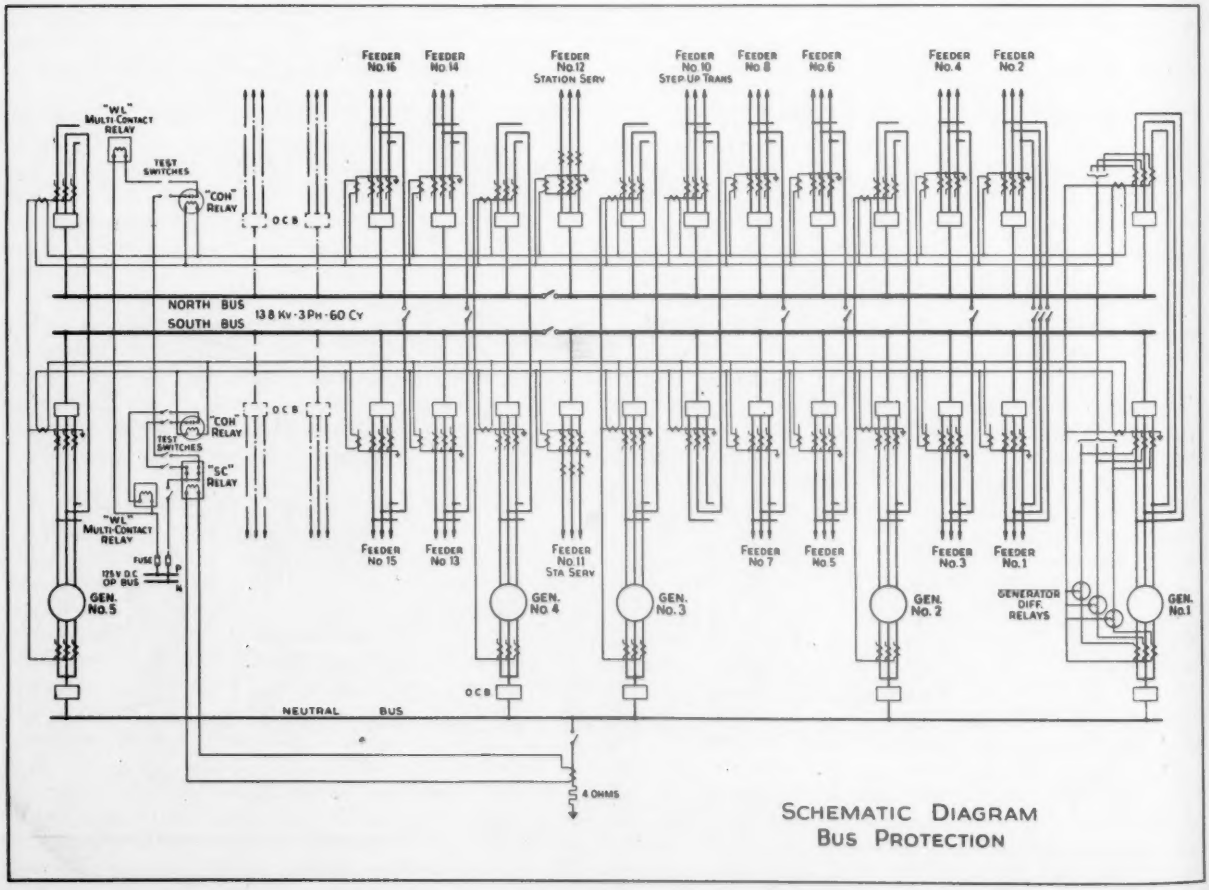

Feeder No. 16
Feeder No. 14
Feeder No. 12 Station Serv
Feeder No. 10 Step Up Trans
Feeder No. 8
Feeder No. 6
Feeder No. 4
Feeder No. 2
"WL" Multi Contact Relay
Test Switches
"CON" Relay
"SC" Relay
OCB
North Bus
South Bus
13.8 Kv - 3 Ph - 60 Cy
Fuse
125 V. D.C. Op Bus
Feeder No. 15
Feeder No. 13
Feeder No. 11 Sta Serv
Feeder No. 7
Feeder No. 5
Feeder No. 3
Feeder No. 1
Gen. No. 5
Gen. No. 4
Gen. No. 3
Gen. No. 2
Gen. No. 1
Generator Diff. Relays
Neutral Bus
4 Ohms
Schematic Diagram
Bus Protection

Fig. 3

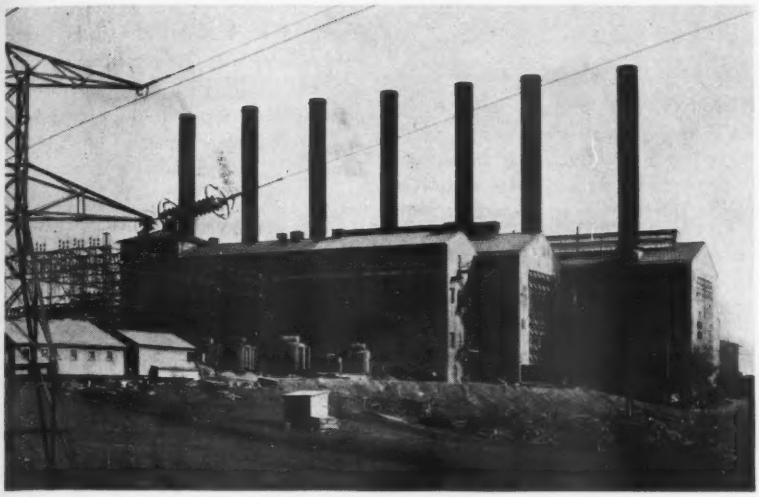


Fig. 4—Louisiana Steam Generating Corp.—1938 Ext.—Louisiana Station, Baton Rouge, La.

Baton Rouge and its vicinity, which take both steam and electricity from the Louisiana Station, the principal industries being those of The Solvay Process Company, Ethyl Gasoline Corporation, and in addition further expansion of the refinery of the Standard Oil Company at Baton Rouge. The added loads require a larger amount of electricity for each pound of process steam than the initial loads, with the probability that at frequent times the amount of process steam will not be sufficient to supply the entire local electrical requirements. To meet the requirements for both steam and electricity, the new units being installed can operate:

1. Full condensing
2. Full extracting
3. Condensing and extracting

When operating full condensing, each unit has a rated capacity of 18,750 kw; when operating full extracting, 15,000 kw; and when operating both condensing and extracting, a rating of 25,000 kw, at unity power factor.

Additional Feeders

To take care of the added requirements of the industrial companies, four outgoing circuits are being installed, one having a rating of 10,000 kva, consisting of a 600,000 c.m. aerial paper lead cable, one a rating of 10,000 kva, consisting of two 250,000 c.m. paper lead cables in ducts, and two having a nominal rating of 12,350 kva each, with an emergency rating of 16,500 kva with one circuit out of service. Each of these latter circuits consists of two 600,000 c.m. paper lead cables in ducts. These four circuits are being provided with reactors as in the original installation.

Feed Water Heater—2300 Volt Auxiliaries

The original design of the station made provision for a feed water heating turbine. On account of the expected increase in process steam and power output, this turbine is now being installed. It will drive a house generator having a rating of 3500 kw, 80% power factor, which will supply power to a new 2300 volt sectionalized bus for auxiliaries. The 2300 volt system will be relayed from the main 13,800 volt bus through a 3-phase, 4375 kva transformer. The house unit is one that was formerly operated at the Baton Rouge Government Street Station. Feed water is heated with 5 lb exhaust steam from the turbine driven boiler feed pumps and draft fans. Normally with the initial installation this 5 lb steam has to be supplemented by steam drawn from the 140 lb mains through reducing valves and, with the growth in the station, the amount of this throttled steam would have been appreciable. Passing the 140 lb steam through a house turbine instead of a reducing valve affords a means of generating inexpensive kilowatt-hours, the exhaust being condensed by and mixed with the feed water.

The major auxiliaries such as fans and boiler feed pumps are steam driven. With the original installation, 440 volts were used for the motor driven auxiliaries as this was the most economical voltage. The house generator available at the Government Street Station is a 2300 volt machine. In view of this and the introduction of condensing units with the good possibility that with further extensions larger motors will be required and in greater proportion, it was decided to introduce 2300 volt switchgear for the larger motor driven auxiliaries. This was estimated to be no more expensive at this time than using 440 volt switchgear for the present extension.

The new 2300 volt switchgear for the auxiliaries is I-T-E air break type, which has been fully described at the

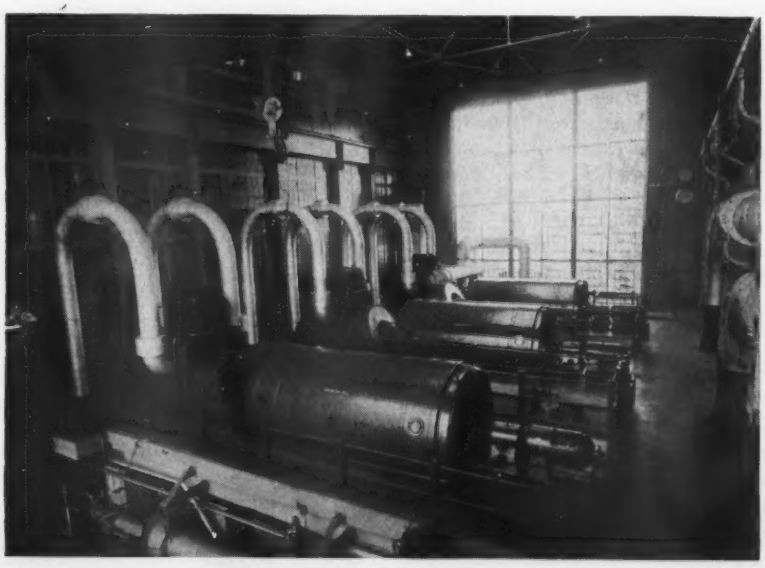


Fig. 5—Louisiana Steam Products, Inc.—Louisiana Station, Baton Rouge, La.

October meeting. Fig. 2 shows main and station service one-line diagram.

River Water Pumps

Most of the water required for steam is make-up water, since the process steam does not return to the plant. In addition, there is required, of course, the water for condensing purposes when the new units are operated as such. The water is obtained from the Mississippi River, which has a variation of 47 ft in elevation and which is located approximately half a mile from the station. At the river there are two 150 hp pumps with 440 volt motors; and a third 150 hp, 2300 volt motor driven pump is being installed. The 440 volt motors are supplied from two 440 volt circuits, each motor having its own circuit. The new 2300 volt motor will be supplied from a new 2300 volt cable which will have sufficient capacity to operate an additional pump.

The pumps at the river obtain water from a well which is connected to the Mississippi River by means of two siphons. These siphons have motor operated vacuum pumps. In the remote case of the pumps losing their suction due to clogging of the siphon, or air, float switches at three levels in the well will shut down the pumps in sequence and prevent loss of the pumps. In case of loss of water from the river, water can be obtained from the water storage system and from connections to the industrial companies adjacent to the plant. The pump house may be non-attended, and the motors can be remote controlled from the station.

Improvements in Protection to Service

The installation of these additional units gives the station a total generating capacity of approximately 100,000 kw, which justifies increased measures of protection to service. These measures consist of:

1. Differential protection for the main buses
2. Installation of CO_2 fire extinguishing equipment on the generators
3. Additional reactors

Bus Protection

The bus protection system adopted is that operating on residual fault current, which system has been previously described in papers presented on other stations. A bus fault will sectionalize and trip out all circuits on the faulted bus. Fig. 3 shows the schematic connections. Provision is made for installation in the future of bus reactors with sectionalizing circuit breakers.

CO_2 Fire Extinguishing Equipment

The CO_2 fire extinguishing equipment is the conventional Walter Kidde type, operating automatically from thermal elements in the air ducts and from the differential relay on each generator.

Reactors and Breakers

In order not to exceed the interrupting capacity of the main oil circuit breakers originally installed, reactors are being provided on each of the three original generators, the feeders already having reactors. The two new generator circuits will have oil circuit breakers with an interrupting capacity of 1,000,000 kva, and these circuits will not require reactors at this time. The new feeder circuits are being equipped with oil circuit breakers having an interrupting capacity of 500,000 kva and reactors to limit a fault to below this value.

A Letter to Charlie

(*Continued from page* 110)

tions in determining taxable income only interest paid or accrued for payment. Therefore, when you generate your own power the only allowable deductions for tax purposes are the actual costs of operating and depreciation accruals on a straight-line basis. On the other hand, if you buy your current the entire expense for power is allowed as a deduction since the whole sum is an operating item. For example, assume that the cost of generating your power, including allowance for interest on invested capital at 6 per cent per year, is identical with the cost of purchasing this same power. If your entire net income is distributed to stockholders the savings in income tax made available by purchasing power will run almost 4 per cent of the total annual cost for power. If you distribute no dividends this saving climbs to 4½ per cent because of the higher tax rate (19 per cent) involved. In states where a State income tax is also collected this latter saving would boost the total to approximately 5 per cent of the annual cost for power. These figures presuppose, of course, that the investment funds liberated by buying power are utilized as working capital, which would be the case nine times out of ten. If, however, these released funds were diverted from working capital to income producing property, a tax would naturally apply on their net taxable earnings and the saving achieved would be reduced by the amount of such tax. Figure it out for yourself, Charlie. It's a peach of a way to preserve your working capital and save money in the bargain.

I've covered a lot of ground in this letter. Perhaps you will think that I'm over enthusiastic about the intangibles connected with Central Station service. Take it from me, straight from the shoulder, I mean every word I say. Those intangibles are worth real money (and they are not so abstract either, once you're acquainted with them). If you persist in nullifying their attractions, don't forget that the cold, hard-boiled, out-of-pocket expenses involved will more than likely bring you to a primary power contract anyway. Naturally there are exceptions but Simplex is not one of them and I've got a hunch that your outfit isn't either.

The great bulk of industrial plants operate at average load factors of from 20 per cent to 50 per cent, the median being around 35 per cent. This point alone is a powerful single argument against tying up money in expensive apparatus. Experience proves that estimated load factors usually exceed the true figures. I don't suppose you know what this power factor business is all about and I'm not familiar enough with it to attempt to explain it to you in detail. The best analogy I've heard likens it to the "collar" on a stein of beer. You're paying for something superfluous which you don't get; in this case, useless magnetizing current which is wasted. Suffice it to say that the utility people opened the subject voluntarily and showed me how to cut purchased power costs (their revenues) just 14 per cent in the interest of my welfare as their customer. I like that kind of attention. Don't you?

Take my tip. Call the Power Company on the phone and tell them you want "the works." Stay in your own line and let the power boys do your electrical worrying for you. That's their problem.

Yours,
BY POWER.
Byron Power.

P.S. Central Station service takes the "ow" out of power and leaves "p . . . er" (purr). Maybe I ought to throw in the sponge and write slogans for a living, eh, Charlie?

Operation of AC Low Voltage Network from Two Voltage Sources

By W. B. Kenyon
Rochester Gas & Electric Corporation, Rochester, New York

A Paper Presented Before the Transmission and Distribution Committee, E.E.I., Sagamore Hotel, Rochester, N. Y., Feb. 8, 1939

AT various times questions have been asked regarding the method of feeder arrangement of the Rochester, New York secondary network system. Most of the secondary networks in the country operate from feeders supplied from generator voltage or transmission voltage. The supply in Rochester, however, at the present time consists of several 4 kv feeders operating in parallel with two 11 kv circuits. It is believed that sufficient interest has been shown in this dual voltage supply to justify the presentation of the following data pertaining to the Rochester system. This information and operating results may be useful to some other company contemplating installation of a new network system.

The network system in this city has progressed through various stages since its inception in 1930. The present feeder system to the network, which will be described in more detail later, is one of the final stages in the supply of the network at generating voltage. Many papers and computations have been presented to show that maximum savings result in bringing the generator or transmission voltage direct to the individual network vaults. It was definitely not economical to begin the Rochester network with feeders operating at generator voltage. The initial network connection would not have been made until a much later date due to the very large expenditure had the high voltage supply been essential.

By 1930 interruptions were becoming exceedingly difficult to arrange for the necessary additions to the radial system which was being installed to care for additional demand. The business district of this city had been supplied for a long time by an underground Edison direct current system. Customers were beginning to change over from the Edison system as their needs for better lighting and air conditioning were realized. A promotional rate was also in effect which provided some savings to customers supplied by the A C system. A number of transformer vaults were already in use, principally for the means of supply to individual customers. The secondary cables began to radiate from these vaults to supply additional customers where it was necessary to make the usual alterations on transformer and equipment to supply the increasing radial load.

Studies had been made for several years previous to determine the ultimate network design for downtown Rochester. These were brought up to date and it was found that the network could be economically justified provided that it was not necessary to install a complete new network system. In order to gain operating experience and also to keep the network expenditure to a minimum, protectors were added at the existing vaults and the necessary cables installed to complete the secondary ties. The existing 4 kv distribution transformers and feeders served as supply to this initial network. Transformers which were in operation and which were to supply this initial network were connected Delta Y. The feeder circuits had considerable radial load outside the network district, as well as some special customers with duplicate 4 kv service within the network area. This arrangement operated successfully for several years. Due to the increasing load and also because the special customers were gradually eliminated, three of the four feeders later became exclusive network circuits. The Y-connected induction regulators which were inherited with the converted radial circuits continued in operation and regulated the network voltage. The control settings of these regulators were high enough to regulate the secondary at considerable distance from the transformers. The operation was carefully observed due to reports of troubles which had existed in other parts of the country but, again, after several years of successful operation, the regulation became matter of fact. The load cycles on the circuits were not the same, but still regulator operation was such that the network protectors did very little pumping at light load.

No major changes were made in the method of supply to the network until 1936. With the improved business conditions of that year quite rapid growth in the network load was anticipated. A new feeder was found to be necessary to take care of the total load and also to provide proper interleaving of transformer banks for emergency conditions. Before this feeder was installed, however, further study was undertaken, the results of which showed that it was economical to start the network supply at generator voltage. Twenty vaults were in operation on the network and only part of them which had been constructed recently were suitable for 11 kv transformers. The expense of vault reconstruction was not justified for the revenue being realized on the network at that time, and, therefore, it was very desirable to continue the existing 4 kv feed and add as many new units as would be required at 11 kv. The secondary cables covered the entire area in which network service was required and, therefore, it was not possible to separate the secondary into two zones, one of which could be operated with 4 kv feeders and the other with 11 kv feeders. Also it was not desirable to install more than one 11 kv feeder initially. The paralled operation of 4 kv and 11 kv circuits would, therefore, be necessary if any 11 kv installations were to be made.

In order that these two feeder voltages could be used, it was necessary to correct

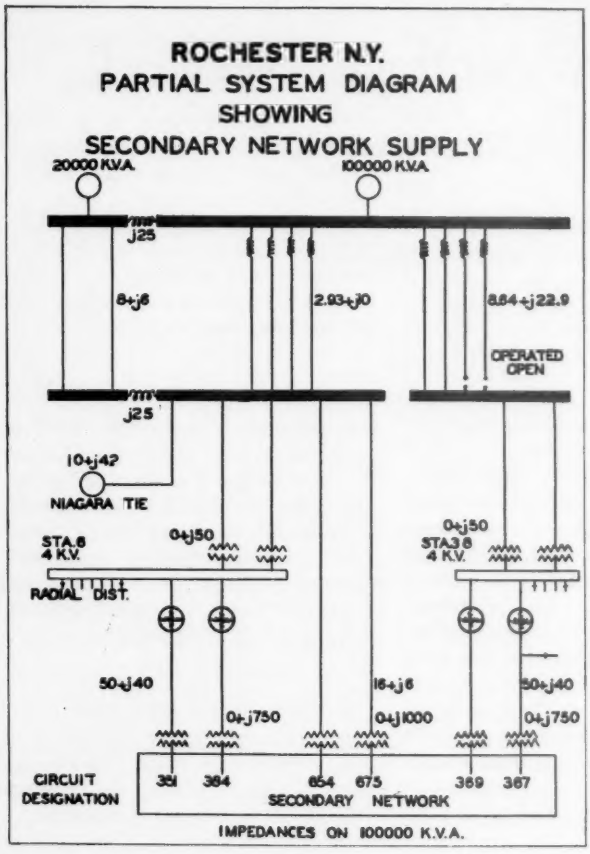


Fig. 1

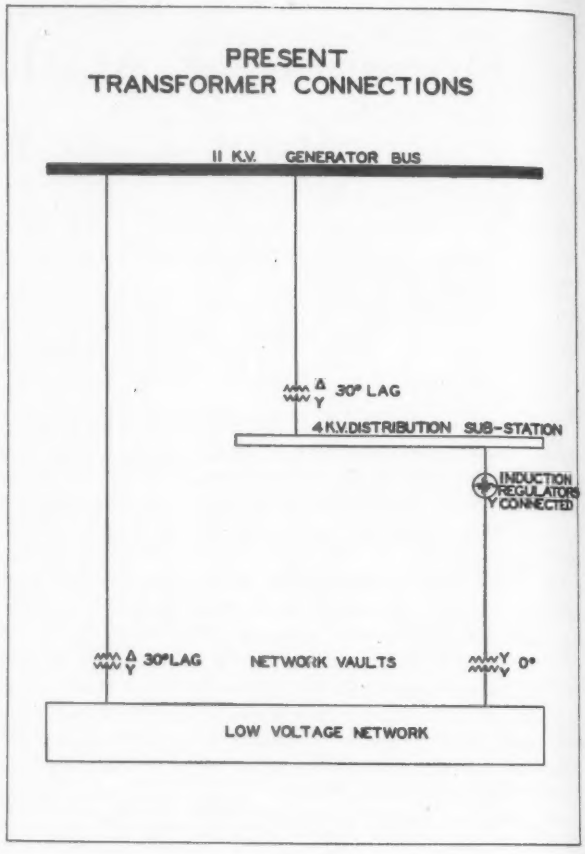


Fig. 2

a phase angle difficulty which existed between the 4 kv and proposed 11 kv transformer secondaries. It was felt imperative that the new 11 kv transformers be operated in Delta Y connection inasmuch as the 11 kv system was only grounded at the generating station. The 11 kv neutral could be taken back to the generating station which was only some two miles from the network area and YY connection used. However, it was decided that this expedient would be distinctly bad operating practice. The system connection diagram Figure No. 2 shows the route of power from the generating station through Delta Y connected lowering transformers at the network supply stations to the 4 kv buses. The network feeders were supplied from these 4 kv buses with the voltage 30° lagging the 11 kv voltage. Vault connections at the network were Delta Y 30° leading the 4 kv voltage and, therefore, in phase with the 11 kv system. The incoming 11 kv network supply transformers would, therefore, have to be connected YY for 0° phase displacements in order to connect the same secondary mains. This is the 11 kv connection mentioned above which for other reasons could not be used. The only alternative, therefore, was to reconnect the existing network banks for YY operation 0° phase displacement which would leave the existing secondary mains 30 electrical degrees lagging the 11 kv system and allow the use of Delta Y 11 kv network transformers as shown in Figure 2.

The network transformer installations consisted of standard single phase line type distribution transformers. These were all operated 4 kv primaries and, therefore, would have to be changed to 2.4 kv primaries to accomplish the YY connection. An economical solution of this problem was again found which was considerably less costly than to install 11 kv transformers and make the necessary vault alterations. By sending some of the transformers to the manufacturer's supply shop for rewinding and reconditioning, and by purchasing a small number of new transformers, the installation could be made. Locations were chosen for new transformers where the

TABLE I—GROWTH OF ROCHESTER NETWORK

Year	Number of Units 4 kv	11 kv	Total	Capacity in kva 4 kv	11 kv	Total	Actual Load kva	Ratio: Load Capacity	National Average: Load Capacity
*1930	9		9	2137		2137	1050	.49	.46
*1931	11		11	2662		2662	1205	.45	.45
*1932	12		12	3112		3112	1525	.49	.38
*1933	12		12	3224		3224	1900	.59	.38
*1934	16		16	4387		4387	2400	.55	.37
*1935	20		20	6187		6187	3300	.53	.41
o1936	21		21	7650		7650	4300	.56	.44
x1937	22	5	27	8100	2500	10600	5600	.53	.44
x1938	24	7	31	9050	3500	12550	6585	.52	

* Regulated 4 kv feeders. Transformers connected Delta Wye.
o Regulated 4 kv feeders. Transformers connected Wye Wye.
x Same as "o" with 11 kv unregulated feeders added transformer connected Delta Wye.

capacity was found to be too low and also where the existing transformers were relatively new. Transformers to be rewound were chosen where there was evidence of aging of the insulation and where the existing capacity was found to be correct for the new installation. By the time the secondaries were temporarily sectionalized into groups and the new transformers installed, the initial group of rewound transformers were ready to be returned to service. These rewinds released other transformers which were changed over by the manufacturer; thus, it was possible to proceed with small groups of transformers at a time and ultimately convert the entire network system over to the desired connections. The capacity in certain vaults was increased at the time of the change-over, and the resultant capacity was sufficient to carry through 1936 without making further expenditures. A few transformers which were released where larger transformers were installed were readily absorbed and soon operating on the lines. The new transformers, together with the former transformers, supplied with complete new primary and secondary windings, gave a system equivalent to all new transformers. Taps were also installed at the time the rewind was in progress to conform to standard and, therefore, any of these transformers which are replaced at a later time may be installed anywhere on the system.

As shown in Table I, 1937 was a year of considerable activity in enlargements on the network system. It was, therefore, possible to make maximum use of the new 11 kv feeder by installing nearly all 11 kv transformers. In some vicinities where the load formerly was very light or where spot loads too large to be handled by one unit were located, it was necessary to install a very few 4 kv units. These were added rather than to attempt to operate more than two 11 kv feeders at this time. The vaults are all constructed in such a manner that the transformers may be changed to 11 kv at a later date.

TABLE II—ROCHESTER NETWORK CIRCUITS

Circuit Number	Number Banks	Capacity kva	Load kva	Power Factor
351	6	2100	1150	92
384	5	2100	1130	87
653	5	2500	1480	98.5
675	2	1000	660	98.5
369	7	2825	1350	96
*367	5	1800	680	96
*375	1	225	135	96
6	31	12550	6585	

$$\text{Ratio} \frac{\text{Load}}{\text{Capacity}} = 52.5\%$$

Average Size Bank 400 kva

* Not exclusive network circuits, have mainly radial load.

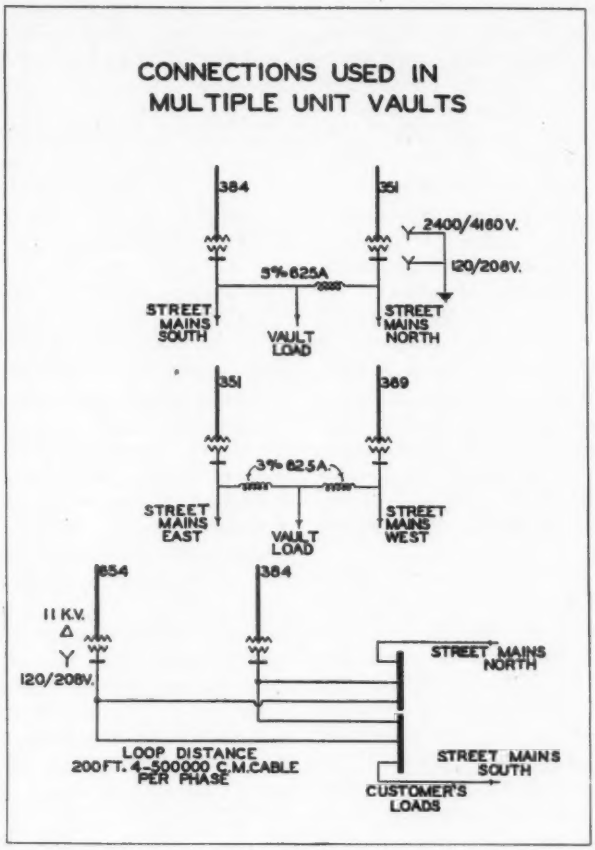


Fig. 3

Thus the expenditures have been kept as low as possible and each step has been economically justified up to the present time. This historical background gives the reasons for operating the network in its present condition. It is probable that as the load continues to grow additions will be taken largely at 11 kv. Many of the existing 4 kv units may be changed to 11 kv when additional vault capacity is needed.

The only precautions which were observed in the design of the network was to make some special arrangements in the multiple unit vaults. Figure 3 shows the three systems which are used in multiple unit vaults. On the first diagram of two secondary network protectors, operated from different 4 kv feeders, is shown the connection of the common cable type reactor which serves to improve balance at times of heavy load. It should be noted that the street mains feed directly from the network protectors, and, thus, no voltage drop is introduced in the cables which supply load outside of the vault. In the street manhole these cables are not connected solidly together, but proceed in opposite directions or to opposite sides of the street to prevent bridging the vault reactor.

The next diagram shows another method of accomplishing the result except that the large vault load is supplied from vaults connected in this manner. The reactance is split and installed on either side of the load in the vault itself. The slight voltage drop introduced by the two reactors in parallel is not objectionable to the customer supplied directly out of the vault. In this manner no additional reactance is introduced in the street mains.

The third diagram shows the connections used for the large customer having two points of entrance, which many network operators call the power and lighting loads. In this case, however, the entire load is cross-connected between two points of entrance in such a

manner that diversity is secured throughout the building and in case of interruption to one of these buses partial service is available to the entire building. In this case, the reactance required to prevent unbalanced load conditions is obtained by method of cable connection. By following the possible route of circulating circuits, it is seen that considerable length of secondary is introduced which in this instance amounts to 200 feet of 4—500,000 CM cables in parallel. No difficulty has been experienced in securing a reasonable load balance by any of these methods. In some vaults insensitive tripping of network protectors was thought to be necessary to eliminate excessive protector operations at light load. These methods of restraint, however, may be removed at some time in the future, as they are not necessary at all times.

On the diagram, Figure 1, is reproduced a sufficient part of the system diagram to show the over-all method of supply to the entire network area. The impedances shown are on 100,000 kva base. By inspection of these values, it is seen that by far the largest impedance by way of any path is introduced by the network transformer itself. Another vitally important factor, however, is the rigid tie line connection from the generating station bus to the two substation buses which supply the network. The loading on these buses, due to connections other than the network, is such that little or no electrical phase displacement exists between these two network supply buses. Slight difficulty was experienced at one time due to a steam heating station which used a 4 kv turbine on a schedule as determined by steam demand. This turbine could be connected to either of the 4 kv network buses. Since the steam demand of this station began early in the morning, and, therefore, turbine operation also began early in the morning, slight troubles were experienced on some of the network protectors supplied from 4 kv. However, in instances where this was discovered reverse current settings of 35 to 50 amperes completely remedied the difficulty. The network protectors in use on the new 11 kv units are all operated in the sensitive condition to allow the transformer charging current to open all network protectors and de-energize the 11 kv feeder as soon as the station oil switches open. The location of the Y connected induction regulators which are still in use on four of the network feeders is also indicated in this diagram. It is believed that regulators may be released from these feeders for other purposes at some time in the future, especially after more transformers are installed at 11 kv. From the present schedule of operations at the generating station it does not appear that regulation of the 11 kv feeders will be necessary.

Table I is a tabulation showing the number of vaults, capacity, load, etc., for the Rochester network since it was first connected in 1930. From 1930 to 1935, inclusive, the network was supplied by 4 kv regulated feeders with transformers connection Delta Y. In 1936 vault transformer connections were changed to YY and from 1937 to date the 11 kv unregulated feeders are beginning to take a major part of the network load. It may be interesting to note that the system is operating at a slightly higher ratio of load to capacity than is true of the country as a whole. The factor in 1937 was .53 while the national average was shown in the A C network operation report as .44. There is no comment upon this feature except to conclude that the network is operating with a slightly lower investment per unit load than for the country as a whole.

HOTEL RESERVATIONS FOR E.E.I. CONVENTION

Room reservations for the World's Fair in New York exceed early estimates in the case of nearly every hotel in the city a newspaper canvass disclosed as this issue of the BULLETIN goes to press.

Both hotel bookings and reports from travel agencies suggest that optimism in forecasting fair attendance is warranted.

"We will be sold out 100 per cent from May to October," many hotel managers said.

It is suggested that hotel reservations for the E.E.I. Convention period, June 6-8, be made as early as possible. A hotel information circular and reservation form has been prepared by the Institute. Copies will reach member companies at about the same time this issue of the BULLETIN is received. Extra copies may be obtained on request to the Secretary,

EDISON ELECTRIC INSTITUTE
420 Lexington Ave., New York, N. Y.

In Table II is shown a summary of circuit detail of the network supply circuits. The interesting fact which is shown on these tabulations is that the power factor is very nearly equal to the load power factor. When the dual supply was first used, it was found that the setting of the regulator control on the 4 kv circuits was such that the 11 kv circuits actually drew reactive kva from the network system. This was corrected by lowering the compensation on the 4 kv regulators which improved their power factor and allowed the network circuits to assume a power factor more nearly equal to that of the load. The regulators on the 4 kv circuits change the voltage on the 4 kv feeders approximately 4 volts from light load to full load. This more than compensates for feeder and transformer regulation, and therefore, compensates slightly for secondary voltage drop. Charts taken at representative locations on the secondary show almost perfect voltage where the network is fully developed. However, on the outer part of the network the regulation approaches that of an equivalent radial system.

No operating difficulties have been discovered in this method of supply which seem of enough consequence to consider the expense of installing all 11 kv transformers for operating reasons. The system seems so stable at the present time that it is not planned to change 4 kv banks unless larger transformers are necessary or where it may be desirable to secure better emergency conditions. It is possible at the present time to operate with one circuit out, but due to the fact that several vaults carry 75 per cent load it is not a desirable condition. If this load increases at the vaults which are heavily loaded, it may be necessary to change the circuit arrangement slightly.

The success of this system depends largely upon the stability of our own generation and transmission facilities. Should it be necessary to carry purchased power into one of the substations which supply the network it would, of course, be necessary to examine closely the conditions on the two circuits supplied from the other substation. This is a rare possibility under present operating arrangements and does not appear serious enough to warrant feeding all of the network circuits from one station. Very little has been spent on network feeders pending a decision as to whether the network should be supplied from one or more substations.

The Pole Top Method of Resuscitating Linemen After Electric Shock

By E. W. Oesterreich
Duquesne Light Company, Pittsburgh, Pa.

A paper presented before the Pennsylvania Electric Association, Operations Section Meeting, Philadelphia, Pa., March 1, 1939

The Accident Prevention Committee, E.E.I., regards with much interest this method for giving artificial respiration to a lineman while on a pole, and congratulates the Duquesne Light Company and Mr. E. W. Oesterreich for this contribution in the field of resuscitation and on that which has been accomplished so far through the use of this technique. The shortening of the time to the starting of resuscitation is the vitally important consideration. The results of a more extended experience with the method will be studied with interest.

AFTER a long period of unsuccessful attempts to resuscitate linemen who had received an electric shock of dangerous proportions, we are today in the position of being able to look forward, with assurance, to the probability of successful resuscitation under similar circumstances. As a result of a comprehensive study of the problem by the Distribution Operating Personnel of the Duquesne Light Company during 1931, a method for resuscitating linemen has been developed and applied with remarkable success. The new method was adopted as standard practice by the Duquesne Light Company almost eight years ago but at that time it represented such deviation from general opinion that any widespread discussion might have created opposition rather than support. It appeared that actual experience would be necessary before any general departure from long accepted practices could be expected or substantiated.

Since that time, and particularly more recently, this method of resuscitation has been adopted by operating companies throughout the country, and its effectiveness in saving the lives of linemen subjected to this treatment has been proven by its record of accomplishment. It already has established the record of 14 successful resuscitations and its use is constantly being extended as more companies adopt the new technique. Unquestionably, additional knowledge has been obtained, but, due to the absence of supporting scientific data or theory, it is extremely difficult to determine the primary agency or factor responsible for the outstanding success.

For this reason it is necessary to resort to a comparative presentation of field experience with the methods under consideration. It is possible that, from a discussion of what has been accomplished, we may learn more about electric shock resuscitation technique and, perhaps indicate a new approach to research pertaining to the physiological processes which are involved in dying as a result of the passage of dangerous electric currents through the human body.

While the experience with the Schafer Method of Artificial Respiration has been fairly satisfactory when we consider all of the different cases in which it is applied, it has been obvious to those individuals who analyzed the statistics, that linemen receiving an electric shock, which results in unconsciousness of the victim, were very seldom resuscitated. This appeared to be the experience, regardless of condition of electrocution, whether the contact was to high or low ground resistance structures and indifferent to the pathway of the current through the body.

The tabulation shows the experience of the Duquesne Light Company, with the various cases classified as to nature of contact, points of contact on the body, and resultant effect upon the human being. It is interesting to note that

One fourth of all victims of electric shock on pole type 2300 volt contacts required resuscitation.

One-half of all victims of electric shock on poles never lost consciousness.

Cases which did not involve the vital organs in the path of the current flowing through the body were never rendered unconscious.

Eighty-five per cent of all cases requiring resuscitation were cases where the contact was made to a low resistance structure such as metallic circuits or earth.

Eighty per cent of all cases where the circuit was completed through a wood pole recovered consciousness without resuscitation, regardless of path of current through body.

In all instances, with one questionable exception, all lineman cases requiring resuscitation resulted in a fatality where the Schafer Method was used. There was no question of the proficiency of the lineman rescue squads. These same men had experienced a normal amount of success in the resuscitation of gas asphyxiation, drowning or electric shock victims. They had been awarded trophies in interdepartmental and inter-company first aid contests, in which contests the application of artificial respiration was an important part.

Apparently some determining factor was responsible for the radical differences in the results obtained by the same

CLASSIFICATION OF 2300 VOLT ELECTRIC SHOCK CASES

PHYSICAL CONDITION AFTER SHOCK	TOTAL NUMBER OF CASES	SECOND POINT OF CONTACT			PATHWAY OF CURRENT THROUGH BODY		
		CABLE SHEATH, METAL STRUCTURE OR EARTH	ANOTHER CIRCUIT CONDUCTOR	WOODEN POLE	LEFT SIDE, ARM OR HEAD TO LEG	RIGHT SIDE OR ARM TO LEG	NOT THROUGH BODY
UNCONSCIOUS REQUIRED ARTIFICIAL RESPIRATION	15	8			5	3	
			5		5		
				2		2	
UNCONSCIOUS REGAINED CONSCIOUSNESS WITHOUT ARTIFICIAL RESPIRATION	15	4			3	1	
			3			3	
				8	4	4	
TOTAL UNCONSCIOUS CASES	30	12	8	10	17	13	
CONSCIOUS	29	14			3	7	4
			1				1
				14	2	8	4
TOTAL CONSCIOUS CASES	29	14	1	14	5	15	9
TOTAL ALL CASES	59	26	9	24	22	28	9

STEP I—The operator approaches from below, placing a leg of the injured man on either side of his safety strap.

STEP II—The operator has worked his safety strap up the pole and has the injured man in a position astride his safety belt.

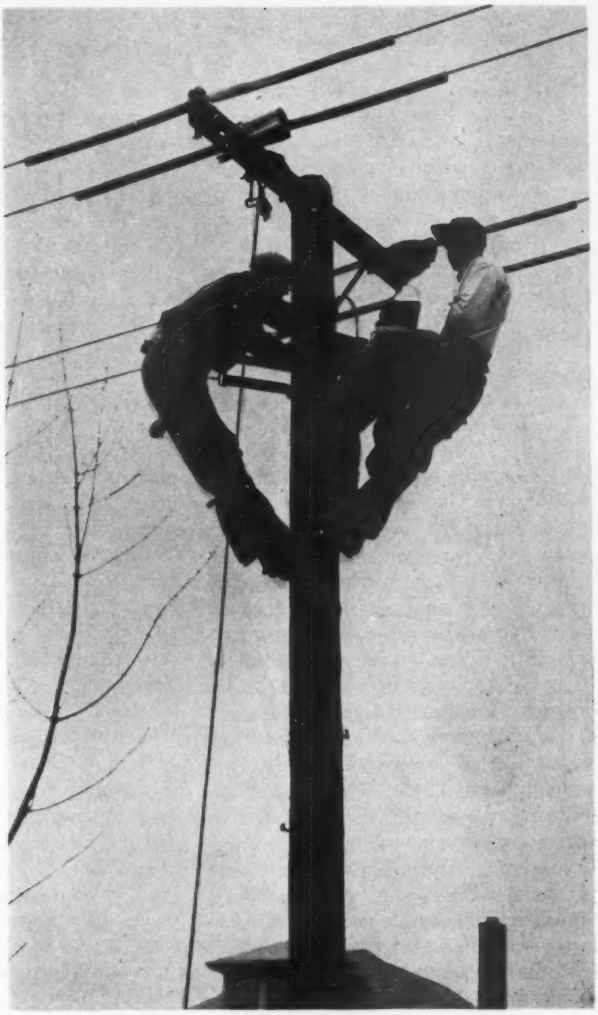
men applying identical treatment. The study of the conditions pertinent to the cases of electrocution indicated only one common difference between the successful resuscitations and the fatalities; namely, *in all cases where a material interval of time elapsed between electric shock and the application of resuscitation, the attempted resuscitation was unsuccessful.*

Obviously, a lineman must be lowered from the pole structure before the conventional Schafer Method can be applied. Experience has shown that under ideal test conditions a body can be lowered from a pole in approximately two minutes. Investigation of actual field cases indicate that the elapsed time is usually considerably greater, in some cases being longer than ten minutes. When consideration is given to the fact that before the body can be lowered, it is necessary to assemble men competent to engage in the rescue work, release the victim from the energized equipment, put up the rope rigging necessary for the safe lowering of the body; the time consumed, even though five to ten minutes, is not unnecessarily long.

It was the thought given to a reduction in the elapsed time which finally led to the development of the Pole Top Method of Resuscitation. The further the study was carried, the more apparent it became that the only solution to the problem was the development of a technique which would permit the application of revival measures at the location of the electrical contact; namely on the pole. Since practically all public utility employees have been thoroughly trained in the application of the Schafer Method it was logical that the first thought would be to simulate the Schafer technique and to obtain, as nearly as possible, the same effect on the anatomy of the human body. This was soon found to be unpractical. Pole structures are not constructed so that a human body can be laid horizontally on a flat surface, which is secure, not only for the victim, but also for the operator astride the victim's body. All possibilities were explored which would permit applying pressure to the back of the victim in all positions either vertical or horizontal. Due to the absence of flat surfaces, no restraining action could be obtained on the abdomen which would produce the resultant upward force on the viscera and diaphragm, which action is an essential requirement of the Schafer Method.

The thought was ultimately developed, that, if in order to be successful, the revival technique must primarily provide artificial respiration; the result

STEP III—Artificial respiration is applied in accordance with the description in the article.



STEP IV—As additional men are available, the rope rigging to lower the victim to the ground can be applied without interfering with the resuscitation activity.

could be obtained to a greater or lesser degree by another method. Since the ventilation of the lungs is dependent upon the movement of the diaphragm, and movement of the diaphragm can be obtained by pressure upon the abdomen, it is reasonable to assume that effective artificial respiration would result if pressure were applied to the front of the body in the abdominal region. This is particularly true if the pressure could be applied over a large area and if the outward movement of the sides of the abdomen could be restrained.

The present Pole Top Method was initially developed to conform to these requirements. By supporting the victim's body in a vertical position in front of himself, with the victim facing the pole, it is possible for the operator to reach around the waist of the victim from in back, and, with outspread hands placed with the thumbs immediately below the lower ribs, apply pressure with the same regular frequency as is used in most artificial respiration methods.

The application of this technique to field conditions did not present any insurmountable difficulties, and improvements which have been developed since the initial application have eliminated most of the original difficulties. At the present time, the procedure in most common use is as follows:

1. The first man to reach the victim clears the body from electrical contact, permitting the body to hang from the safety strap alongside the pole if possible.

2. The rescuer then takes a position below the victim on the pole and after placing his safety strap around the pole, proceeds to work his way up with one leg of the victim on either side of his safety strap, and with the body of the victim between himself and the pole. When the safety strap is as high on the pole as can be reached, the weight of the victim's body is taken in a straddle position on the safety strap of the operator.

3. The mouth of the victim is cleared of foreign substances, the tongue is pulled out and the head pushed forward toward the pole.

4. The operator then encircles the waist of the victim (under arms) placing both hands, one from each side, on the abdomen of the victim, thumbs below the lower ribs and fingers touching.

5. The operator applies a constricting action with his arms and hands, obtaining a compression force, in an upward direction on the upper abdominal region. At the finish of the stroke the hands should be cupped with the fingers depressing the abdomen under the breast bone. The pressure is then released and periodically re-applied at a frequency of 12-15 per minute until the victim regains consciousness or the resuscitation is to be discontinued.

6. When the victim has recovered sufficiently to be breathing naturally, the operator shall retain the victim in position and under operative control until the unusual violence some times associated with recovery

(*Continued on page* 126)

Customer Benefits Prize Paper

Why Purchase Electric Power from a Public Utility?

By John Howell, Jr.
Buffalo Niagara Electric Corporation, Buffalo, N. Y.

A prize-winning paper in the recent Industrial and Commercial Customer Benefits Contest

MR. INDUSTRIALIST and Mr. Commercialist — this article is addressed to you whether your business is large or small, whether you are president of a large corporation or operate a little shop, whether you now purchase your electricity from a public utility or generate it yourself with your own steam generating plant, diesel engine or other source of motive power. In view of the increasing publicity and claims being made for diesel engines many of you purchasing your electricity from a utility are wondering no doubt, whether you are pursuing the wisest course. Likewise, because of the many new factors introduced into business in the past few years requiring adjustments in methods and policies, many of you who are now generating your own power are feeling the necessity of taking stock of your situation and making plans for the future with regard to your electric power policy.

Economic law demands that every advantage of purchasing your power from a utility or generating it yourself be interpreted in dollars and cents in your pocket. In this article I will not discuss the factors involved in making an engineering survey to determine the comparative cost to you of purchased or privately generated power at the moment. This is a job for an honest, impartial, well informed power engineer who can give detailed study to your individual conditions. However, I will endeavor to point out all factors which may operate in the future to nullify such a survey.

First, let us consider what may happen to the money you invest in a private power plant. Although the life of diesel engines may be five or more years and that of steam generating plants twenty or more years depending upon the use and care given them you can not expect to recover much more than their scrap value in event you should wish to dispose of your power plant. Purchasers are rare; power plants are designed for a user's particular needs, and installation and housing costs represent a large part of the investment. Your only opportunity for recovering most of this investment, then, lies in operating it for a sufficiently long time at a sufficient saving over purchased power to pay back the principal invested. Furthermore, if the investment is to be considered a paying one it should earn a fair rate of interest. I think you will agree that twenty years is a long period in the life of an average business and even in five years a vast number of changes can occur to upset long term calculations. Witness the last few. You are all aware that no business stands still. It is either growing or declining over more or less of a long term as well as fluctuating from year to year with general business conditions. Frequently the entire nature of a company's business changes in a comparatively short time as the carriage business changed to the automobile business and as the street railways are giving way to buses. Many businesses must be prepared to fluctuate violently with events beyond their control as the brewing, distilling and associated industries did with the coming of prohibition and as wartime industries were affected by the world war. Frequently new processes requiring more or less steam or power quickly render old methods obsolete. Kiln drying of lumber at the saw mill, effecting savings on freight, has eliminated the largest need for steam in the lumber and mill work industry. In the merchandising business the trend toward greatly improved lighting and air conditioning in the past few years has greatly increased power requirements. Such are the uncertainties of the future which may quickly turn a golden investment in a power plant to brass by rendering it idle and unsalable, by making it too small or too large for modified power requirements or by removing other needs for steam without which it could not be economically justified.

In periods when power requirements are low a business with a private power plant will find itself saddled with a heavy investment on which the fixed charges of depreciation and interest may rapidly eat up any savings over purchased power made in good times. Maintenance to power plant buildings and equipment, and operating labor also remain practically the same in periods of reduced output. How far ahead can you predict your business will grow or hold its own and how steady will be its growth? In the writer's experience businessmen complain most about high costs when business is poor. This is only natural. We don't mind paying a little more for things when business is good and we are making a fair profit. So remember the times when business is bad are the times privately generated power comes dearest.

It will be the undepreciated investment in a private power plant which takes the savings and joy out of installing improved processes requiring less steam or power. And should you wish to contract your business or go out of business you must be prepared to absorb the loss on the undepreciated part of your power plant investment.

You may raise the point that public utilities have fixed charges and their rates are step rates whereby they charge more for the first given block of a certain number of kilowatts and kilowatt hours than for successive blocks. Consequently you will contend that in periods of low consumption you will have to pay a utility more per kilowatt and kilowatt hour for electricity than when your consumption is large. That is true, but utility rates are based on the

diversified risk of most of the businesses in their territory and your cost per unit of electricity will not increase as much as it would with your own generating plant at times when your business falls off more than the general average in your utility's territory. You may also point out that most utilities have minimum charges for a certain percentage of a customer's peak power use whether he uses that percentage or not in any given month. Again that is true but the great majority of minimum provisions do not take effect until a customer's consumption is considerably below normal use. For larger consumers who make contracts for power for a certain period of time these minimum provisions are in almost all cases a flexible part of the rate schedule and contract which may be adjusted at contract dates. Most contracts for utility power run only for a comparatively short term while investment in a private power plant may be considered a five to twenty year contract depending upon the type of plant if it is not expected to pay for itself in considerably less than its useful life.

The danger of capital losses and the danger of losses due to fixed charges on the capital invested in a private generating plant discussed above, while based on a somewhat pessimistic outlook for your business, are still items to which a realistic executive will wish to give serious consideration. But business and industry must go on and yours of course will be expanding. If your business is in the growing stage you are now or may soon be confronted with the problem of what size plant to install or how much capacity to add. You must consider that if your business continues to grow and you are too conservative in your decisions as to the size of plant you install and the capacity you add from time to time you will end with several small units less efficient, occupying more space and representing a considerably greater investment than a small number of large units. If you are too optimistic you will have made a large, wasted investment. If your business or industry is located in a building or district where you can not readily add to it at a later date at reasonable cost to meet increasing needs, the floor space occupied by a private plant may be so badly needed for your business that any advantage over purchased power is wiped out and you will be faced with the necessity of scrapping your investment in a power plant to secure manufacturing space or expanding your building at an excessive cost. In contrast to these possible (or rather I should say probable) ways in which your investment in a private power plant may be lost consider that when you purchase power from a utility practically no investment is required. Large consumers who wish to take advantage of lower utility rates for power purchased at higher distribution voltages must make some investment in switching and protective equipment and transformers but it will be very small in comparison with a private power plant capable of delivering the same amount of power. Also it will occupy only a small fraction of the floor space.

Let us consider the question of reliability of service. You must be prepared to include losses in fixed charges on your plant and machinery, loss of goods in process, and loss of wages paid out while no productive work is done in event of power failures. It has been pointed out that large generating units are much more efficient than small ones. Opposed to the operating advantages of one or two large units is the fact that to provide adequate spare equipment in event of failure of a regular unit another large unit representing a big percentage of the total investment in power plant will be required and will stand idle most of the time. Only very large power plants can enjoy the advantage of high operating efficiency obtained from large units and still provide full standby protection with an investment which is a small percentage of the total because of the diversified risk in having several units. The failure of a boiler, turbine, diesel engine or generator is frequently due to trouble which requires several hours to repair even if spare parts are readily available, and lengthy shut-downs may be anticipated. In comparison your utility company has vast resources. It has spare capacity in boilers and turbo-generators actually running at all times and all necessary spare equipment to provide for generating station failures. Probably it has interconnections between two or more generating stations and with other utilities and generating plants many miles distant which can be used to maintain power service in event of major trouble or disasters to local generating plants. To a large extent, especially in vital and congested metropolitan districts where electric service is underground, it has duplicate feeder and distribution equipment. It is true that utilities have many thousands of distribution lines which are not duplicated but practically all of these are pole lines above ground. Ordinarily, damage to these lines which causes power interruptions is of a minor nature and utilities maintain ever ready an adequate force of well trained men and service equipment who can easily and quickly repair it. It is only in times of major floods or disasters, when business is paralyzed from other causes as well, that damage to distribution lines occurs which can not be quickly repaired, usually in a matter of minutes.

The business or industrial plant with its own power plant runs a far greater risk of power interruptions due to strikes than the purchaser of utility power. So many vital services such as hospitals, water supply and fire protection depend on utility service that no one can afford to be responsible for interruptions to their service for any cause, humanly possible to prevent.

Next let us consider factors which may increase operating costs of private power plants. Demands for gasoline and lighter furnace fuel oil, the more valuable products of crude oil cracking, are requiring deeper cracking of the crude: hence fuel oil is no longer a by-product of which there is a great surplus to be sold at a low price. In addition to this, moves to impose federal or state taxes on diesel fuel have received considerable attention. Although the present disposition is to exempt from taxation diesel fuel used in stationary engines, the need for additional revenue or pressure from coal producing interests may force a change in policy that will increase diesel operating costs. In recent years labor has shown a persistent determination to increase its wages. In addition to the probability that your direct labor costs will increase this trend will be reflected in higher costs of coal or fuel oil. It is true utilities will be similarly affected but not as greatly. In their large scale operations materials and power are handled in greater quantities with more labor saving equipment and labor does not play such an important part.

Increasing real estate taxes must necessarily increase the building and floor space overhead charged to private power plants.

Next let us look at control over costs with a private power plant. We all learned early in life that knowledge is power. If any of you are still the least bit in doubt on this point try this experiment at your first opportunity. While strolling down the avenue with a clear path ahead close your eyes tightly and note how your progress is retarded. How many of you have longed for the precious eyes of a rigid cost accounting system which would present to you a constantly

moving picture analysis of your costs and an integrated picture of all overhead, operating expense and supervision attributable to certain jobs, prices of equipment or processes so that you would know their true cost and efficiency? Undoubtedly, many of you, for only the largest concerns are able to afford the additional overhead of a detailed cost accounting system.

Now the generation of electric power is a business in itself even with the most simple type of plant. The cost of power is made up of a vast number of costs including coal or fuel oil, water, water treating compound, operating labor, maintenance charges of all descriptions and fixed charges which obstinately refused to stay fixed as we have shown. There are administrative expenses including time and expense of purchasing, engineering and accounting departments if your business is large enough to warrant such distinct departments. Also, considerable executive time must be given to making decisions. This emphasizes the difficulty in keeping accurate account of power costs and in predicting what power costs will be for operation of your business at various capacities if you generate your own power. When the generation of power from steam is done in connection with the generation of process steam or building heating then the continuous accurate separation of power costs from other steam costs complicates the problem even more.

Most private power plants are installed as the result of an engineering and cost survey at some one time and then because an irrevocable long term investment has been made and because of the excessive accounting involved accurate costs are rarely kept. Little is done to check costs accurately unless some major expenditure in connection with power plant equipment is necessary. Few owners of private power plants know whether they have or will make or lose money on their plant over its entire life to say nothing of how much. The business executive with a private power plant is reluctant to probe into his power costs. He feels that he has made his bed and must lie in it unless it is utterly intolerable, that is, unless his actual operating costs approach the cost of purchased power—and on first thought we may be inclined to agree with him. But the error of his ways is this. Power plants or one of their large items such as a boiler or generator seldom wear out completely at one time and unless the executive accurately knows all his costs he may be lured indefinitely into operating an uneconomical plant through a series of smaller capital replacements.

In striking contrast with the accounting problems presented by a private generating plant, when power is purchased from a utility company you are presented with an almost all inclusive record or power consumption and cost once each month and you can accurately and easily predict your power costs for any percentage of capacity operations from your fixed rate schedule.

The effect of taxes in cutting down the savings a private power plant may be expected to show is one often overlooked although important. In periods of operation when a private power plant can show a saving over purchased power after all costs except taxation have been considered this saving must necessarily be reflected in corporate net income. The Federal 15 per cent tax on corporate net income will compel you to share this saving with the government to that extent. If for any given period of operation you do not charge yourself sufficiently for power you will pay an income tax on more than your true profit during the period which you cannot recover at a later date.

The undistributed profits tax running up to more than 50 per cent has made it increasingly difficult to conserve working capital. If you pay this tax to conserve capital and then invest it in a private power plant you will have increased the cost of the investment by the amount of the tax paid. Now working capital is the cushion which will carry your business over hard times, which will enable you to modernize your plant and cut costs and which will enable you to finance profitable orders. Is it not the wisest policy to invest your surplus capital in modernizing your plant and machinery, essentials to your business; to maintain an adequate supply of working capital to weather recessions and finance operations and concentrate upon obtaining new business before you make a doubtful long term, irrevocable, non-essential investment in a private power plant?

Let us look at the utility picture as a whole with regard to the future of electric rates. The industry shows a history of steady reductions in rates due to technological developments in improving generating, transmission and distribution efficiencies. The development of new uses for electricity which have resulted in the use of generating capacity a greater percentage of the time has reduced the average cost of a kilowatt hour of electricity by spreading the fixed charges on the same amount of generating and distribution equipment over a greater number of kilowatt hours sold. Likewise, an increasing number of customers per unit length of distribution lines has reduced the cost of electricity by spreading fixed charges on the same length of distribution lines over a greater number of kilowatt hours sold. Everyone wants and needs electricity and electrical appliances because of their fundamental contribution to comfort, health and ease of living. All indications are that those factors which have made possible rate reductions in the past will continue to operate in the future. It is true that steadily increasing real estate, franchise, gross and net income taxes are factors which have offset gains during the past few years. This situation has been reflected in decreased utility earnings and greatly reduced returns to stockholders, but, has resulted in few, if any, rate increases. Whether the tax burden will be allowed to increase by the people of the country until it renders negligible or eliminates all return to stockholders remains to be determined. But it is certain the tax burden will meet tremendous resistance to increase should it necessitate rate increases for then almost everyone will be affected in a vital necessity for life at its present economic level. Consequently we may count on utility rates decreasing or at least remaining at present levels.

Most of us also have learned in our experience that an honest, intelligently directed effort eventually brings a return in proportion to the intelligence of direction, concentration of purpose and intensity of effort exerted. Those of you who have achieved the steadiest progress and greatest success have conducted your business on this principle. Your efforts have been to reduce to a minimum the elements of chance in your business. For when we gamble as much is lost as won and the house takes its cut. Some of you may say that to be enterprising and achieve progress we must run risks fearlessly. Certainly, but we can be proud of our ingenuity, energy, and wisdom as well as our courage and we cannot be proud of risks run when the return was not worth it. Wouldn't you be further ahead to concentrate your efforts on your main line of endeavor and leave the power business to the utilities.

RECENT PUBLICATIONS

TURBINES, CONDENSERS AND PUMPS, 1938

E.E.I. Pub. F-14. A report of the Prime Movers Committee, Edison Electric Institute, 34 pages. Price, 70c. to members and their employees; $1.75 to non-members in the U.S.A.; $1.85 to foreign countries.

This report contains statements by the Subcommittee, Operating Companies and Manufacturers on:

Turbine Operating Data for Year 1937.

New Turbine Installations.

Turbine Operating Experiences.

Condensers and Circulating Water Pumps.

Cooling Towers.

Boiler Feed Pumps.

This report covers operating data for 294 turbines of 20,000 kw capacity or larger and 17 turbines operating at pressures of 1200 lb. gage or higher.

For 294 turbines operating at pressures lower than 1200 lb. gage, an average service demand availability factor of 95.53 per cent is reported for 1937 as against 96.30 per cent for the previous year, while the service demand factor is 68.47 per cent as against 66.13 per cent for the year 1936. The unit capacity factor shows a decrease from 48.21 per cent in 1936 to 44.17 per cent in 1937.

The total outage factor for the 294 turbines was 8.28 per cent as against 8.58 per cent for the previous year.

For the 17 high-pressure turbines, an average service demand availability factor of 93.15 per cent is reported as against 89.25 per cent for the previous year.

In addition to the 17 high-pressure units listed, 3 additional units operating at 1200 lb. gage, 900 F. were reported on but not included in the tables for 1937 since their operation covered less than the period hours.

Twenty-four new installations were reported on as completed or in process of installation since the 1937 report was submitted. A tabulation of these 24 installations is submitted; 15 plants are of the 2-pass design and nine are of the single-pass design.

Welded construction with rigid connections to the turbine exhaust is general practice.

The use of different metals for condenser tubes is tabulated and discussed. With reference to tube sheet material, 18 plants are installed with Muntz metal tube sheets and six with steel. Metallic packing is generally preferred by companies using packed joints.

Statements by General Electric Co., Westinghouse Electric & Manufacturing Co., and Allis-Chalmers Co. are submitted describing new turbine installations and design features. The Foster Wheeler Corp., Ingersoll-Rand Co., and Westinghouse Electric & Mfg. Co. give statements concerning condensers, circulating water pumps, special valves, cooling towers, etc. The Allis-Chalmers Mfg. Co. and DeLaval Steam Turbine Co. furnished statements on boiler feed pumps.

BOILERS, SUPERHEATERS, ECONOMIZERS, AIR HEATERS, AND PIPING, 1938

E.E.I. Pub. F-15. A report of the Prime Movers Committee, Edison Electric Institute, 65 pages. Price, $1.00 to members and their employees; $2.50 to non-members in the U.S.A.; $2.65 to foreign countries.

This report contains statements by the Subcommittee, Operating Companies, and Manufacturers covering operating and design problems related to boilers, superheaters, economizers, air heaters and their auxiliaries.

The report continues the tabulation and analysis of data on Boiler Outages started last year.

A compilation of the practices of Operating Companies in the welding of piping for high-temperature high-pressure service is included.

CABLE OPERATION, 1937

E.E.I. Pub. F-16. A report of the Transmission and Distribution Committee, Edison Electric Institute, 36 pages. Price, 60c. to members and their employees; $1.50 to non-members in the U.S.A.; $1.60 to foreign countries.

During 1937 there was an increase of 2.5 per cent in the amount of cable being operated by the 56 companies contributing to this report.

The trouble rate for all high voltage cable has remained virtually constant for the past three years at 7.1 troubles per 100 cable mile-years. The service failure rate of 4.2 is 6.4 per cent lower than the 1936 value but is still 6.9 per cent higher than the corresponding rate for 1935. During this three year period there has been a definite downward trend in the test failure rate which has decreased from 1.3 in 1935 to 1.0 in 1937. The removal in anticipation of failure rate of 1.9 increased 29 per cent over the corresponding value for 1936 and is equal to the value reported for 1935.

The trouble rate for paper insulated cable was 7.0 troubles per 100 cable mile-years. The service failure rate of 4.1 decreased 3.1 per cent, the test failure rate of 0.9 decreased 16 per cent and the removal in anticipation of failure rate of 2.0 increased 29 per cent from the corresponding 1936 values.

The trouble rate for all high voltage joints has steadily increased during the past three years to a value of 1.9 troubles per 1000 joint years. This rate is composed of a service failure rate of 0.7, a test failure rate of 0.3 and a removal in anticipation of failure rate of 1.0. The combined service and test failure rate of 0.9 is 20 per cent lower than the corresponding rate for 1936. The anticipated failure rate of 1.0 represents an increase of 151 per cent over the corresponding rate for 1936.

The total pothead trouble rate was 6.6 troubles per 1000 pothead years, an increase of 3.0 per cent over that of 1936. This was composed of a failure rate of 2.2 and an anticipated failure rate of 4.3, the former having decreased 17 per cent and the latter having increased 18 per cent when compared to the corresponding rates for 1936. The trouble rate for potheads integral with apparatus was 3.2, the failure rate being 0.9 and the anticipated failure rate 2.4. Potheads installed out of doors had a trouble rate of 16, the failure rate being 4.7 and the anticipated failure rate 11. Potheads installed indoors had a trouble rate of 3.1, the failure rate being 2.2 and the anticipated failure rate 0.9.

Approximately 72 per cent of the cable and joints covered in this report were subjected to high potential testing. The failure rate in service was less on tested cable than untested for both cable and joints, the former by 14 per cent and the latter by 9.6 per cent. However, the failure rate (service and test) was higher on tested than untested cable, the former by 15 per cent and the latter by 36 per cent.

A total of 4010 tests were reported of which 21 per cent were made with A C potentials and 79 per cent with D C potentials. The average ratio of test to operating voltage was 1.5 for A C test potentials with a maximum ratio of 3.0 and a minimum ratio of 1.0. For D C test potentials this ratio was 4.3 with a maximum ratio of 6.3 and a minimum

ratio of 2.1. Approximately one out of every 16 tests produced a failure.

The failure rate on solid-type, paper-insulated cables with joints connected to oil reservoirs was 53 per cent less for cables and 35 per cent less for joints than for the corresponding equipment not connected to oil reservoirs; the trouble rate, however, was 34 per cent higher for cables and 67 per cent lower for joints.

Data submitted by the Electrical Testing Laboratories covering the assigned causes of 842 cable troubles shows that approximately one-half were assignable to three causes, namely: sheath corrosion (18 per cent), initially defective sheath (18 per cent) and external mechanical damage (12 per cent).

PLANT COORDINATION COMMITTEE APPROVES REPORTS

The Joint Committee on Plant Coordination, of the Edison Electric Institute and Bell Telephone System, has approved the following reports by the Joint Subcommittee on Development and Research:

Provisional Report 25—Effects of Bonding Telephone Cable Sheaths to Multi-grounded Power Neutrals in Water Pipe Areas.

Provisional Report 26—Grounding of Street Lighting Brackets.

Provisional Report 27—Staged Tests and Operating Experience on 140-Kv Petersen Coil System.

These reports were briefly described in an article entitled "Meeting of the Joint Subcommittee on Development and Research," on Page 38 of the January issue of the BULLETIN.

Copies of these reports in mimeograph form can be obtained from the Edison Electric Institute at a price of 40c to members and their employees, and $1.00 to non-members, for Provisional Reports 25 or 26. The corresponding prices for Provisional Report 27 are 80c and $2.00.

AEIC SPECIFICATIONS FOR OIL CIRCUIT BREAKERS

The Specifications for Oil Circuit Breakers, prepared by the Committee on Electric Switching and Switchgear of the Association of Edison Electric Illuminating Companies, and approved by the Electrical Equipment Committee of the Institute and the Joint Committee on Oil Circuit Breakers of the A.E.I.C.-E.E.I.-N.E.M.A., are now available in printed form.

These Specifications are intended to be used by purchasers and users of oil circuit breakers as their specifications in the preparation and request for prices. As as alternative, if desired by the purchaser, they may be used only for reference purposes by him, or by the manufacturers. The specifications apply to all oil circuit breakers having rated interrupted capacity greater than 50,000 kva, both indoor and outdoor, and in the following voltage classes:

Indoor ....34,500 volts and lower

Outdoor ..15,000 volts and higher

The specifications of necessity include some elements of construction and material, but are not intended to preclude ingenuity of design or improvements. They are intended to become effective on and after January 1, 1939.

The Committee recognizes that these specifications are by no means final or complete, and would appreciate having any comments on their usefulness, or suggestions for their improvement arising from their use. The specifications may be obtained from the Institute at 40c per copy to members and $1.00 to non-members.

The Pole Top Method of Resuscitation

(*Continued from page* 121)

has passed, and the victim has reached a rational status. Resuscitative measures are to be immediately re-applied upon lapse into inanimate condition.

7. Additional workmen, as assembled, will obtain and arrange rope rigging on the structure, securing the victim to the lowering line without interfering with the action of the operator.

8. After recovery, or in case resuscitation on the pole is to be discontinued, the victim is either assisted or lowered from the pole.

All instructions should stress the point that TIME is of utmost importance.

The results obtained by the application of this method have been phenomenal. In our own company, we have been able to change our experience record from very near zero success to 100 per cent success. Other companies have had practically the same results. To date there have been 16 applications of the Pole Top Method, of which 14 have resulted in success. In one of the two remaining cases the Pole Top Method was discontinued very shortly after it was started and the body was lowered to the ground and the Schafer Method was applied without success. In the other remaining case, the body was lowered from the pole after the victim became violent upon recovery after application of the Pole Top Method. While lowering the body, the victim lapsed into unconsciousness. The Schafer Method was applied on the ground and the victim, while showing signs of life several times afterward, finally was pronounced dead. In this latter case the condition of electrocution was peculiar in that the victim made contact and remained in contact position for some time, lying across two phase conductors of a 4800 volt system, with the vital organs in the comparatively low resistance circuit path between the two conductors spaced slightly more than a foot apart.

All successful pole top resuscitations have been accomplished in less than five minutes' application of resuscitative measures. In no case has the victim failed to respond to the treatment and has not indicated signs of life before the work necessary to lower him to the ground had been completed.

At the time that the Pole Top Method was first conceived, the objective was to simulate the effects of the Schafer Method. The consistently successful results obtained promote the thought that perhaps there is some fundamental difference between the two methods which accounts for the effectiveness of the method other than the shortening of the time interval between shock and application of resuscitation.

Unfortunately, information as to the pathological and physiological processes involved in electric shock is not voluminous, nor is there general accord among scientists as to these changes or their sequence.

Is it possible that the resuscitative technique of the Pole Top Method is accomplishing treatment effective in other ways besides providing respiration assistance? Is the more intimate contact with nerve centers in the solar plexus region responsible for the response obtained? Is a paralyzed diaphragm relaxed or a heavy congestion of blood in the abdominal viscera relieved by the positive manipulation? Only time and research will answer. Regardless of the final conclusion, one important fact is obvious and that is, in the past we could not resuscitate linemen by applying the Schafer Method after lowering them from the pole, whereas today we are resuscitating linemen with the Pole Top Method.

E.E.I. Accountants Invited to A.G.A. Conference

THE Accounting Section of the American Gas Association in a communication from its chairman, Mr. H. A. Ehrmann, to Mr. Bernard S. Rodey, Jr., chairman, E.E.I. General Accounting Committee, has extended a cordial invitation to accountants of member companies of the E.E.I. to attend the A.G.A. Accounting Conference to be held at White Sulphur Springs, W. Va., April 20 and 21.

The program, as evolved by the Planning Committee, covers many of the problems with which the accountants of the industry are now struggling. Sessions have been arranged for mornings and evenings, leaving the afternoons free for recreational activities. Ample time has been allowed for full discussion of all subjects.

In addition to the regular committee reports to be presented, addresses will be made by a number of leaders in the accounting field. Hon. Nelson Lee Smith, president of the National Association of Railroad and Utilities Commissioners, is scheduled to address the Conference on the opening day.

A condensed program for the Conference follows:

April 20

Uniform System of Accounts—H. C. Hasbrouck.

Accounting and Property Records in the Regulation and Management of Public Utilities—Hon. Nelson Lee Smith.

The Line Between Maintenance and Capital Items—L. Y. Meneely.

Methods of Computing Overhead Construction Costs—F. Warren Cooper.

Methods of Accounting for Taxes—E. I. Bjork.

Interpretations and Usage of the Various Types of Units Required for Continuing Property Record—J. L. Sunday.

Some Practical Aspects of Cost Determinations—Bernard S. Rodey, Jr.

Work Order Systems—A. V. Schwartz.

Distinction Between Gas Production, Transmission and Distribution Plant—E. Wressel.

Property Records—A New Field of Endeavor—Stuart F. Kosters.

April 21

Depreciation Accounting—H. C. Hasbrouck.

Consistency in Accounting for Depreciation—F. B. Flahive.

"Remaining Life" Method of Determining Annual Depreciation Charges—C. E. Packman.

Business Research in Public Utilities—Stanley P. Farwell.

Customer Bookkeeping Plans of Three Companies—R. B. Milne.

(a) Unit Desk Plan—O. Ullery.

(b) Station Plan—J. A. Williams.

(c) Unit Group Plan—A. W. Fyfe.

Getting Results From Personnel—H. F. Willis.

Customer Accounting and Customer Relations Problems—H. E. Cliff and H. F. Willis.

Sound Film Pictures—Customer Relations—H. F. Willis.

Printed copies of the program will soon be available and will be mailed to E.E.I. accounting people. Copies also may be secured direct from the secretary of the Accounting Section of the American Gas Association, 420 Lexington Avenue, New York City.

Spring Meeting of Engineering Committees to Be Held in May

ARRANGEMENTS have been completed for all of the Engineering Committees to hold their Spring Meeting at the Edgewater Beach Hotel, Chicago, Illinois, May 1 to 4 inclusive. The tentative arrangements for these meetings are as follows:

Accident Prevention Committee	May 2 and 3
Electrical Equipment Committee	May 1 and 2
Hydraulic Power Committee	May 3 and 4
Transmission & Distribution Committee	May 3 and 4
Prime Movers Committee	May 1 and 2
Underground Group	May 2
Meter & Services Committee	May 1 and 2
(EEI—May 1; AEIC—May 2)	
Group Meeting (Evening)	May 2

Tentative programs indicate that all of the committees will have interesting and full programs for their meetings. Programs for these meetings will be published in the April issue of the BULLETIN.

Northwest Engineers to Meet

ENGINEERS of the electric utilities, manufacturers and jobbers of the Pacific Northwest will meet at Seattle, Wash., April 19-22, 1939, in the 16th annual meeting of the Engineering & Operation Section, Northwest Electric Light & Power Assn. Headquarters are at the Olympic Hotel.

A. Vilstrup, chief engineer, B. C. Electric Railway Co., Vancouver, who is Section chairman, has allotted a one-half day session to each of six committees who will present timely papers and discussions on subjects pertinent to their committee functions. Saturday, April 22, will be devoted to trips being arranged by J. Hellenthal, Puget Sound Power & Light Co., chairman of the local arrangements committee.

New York Safety Council Convention

THE Tenth Annual Convention of the Greater New York Safety Council will be held at the Hotel Pennsylvania, March 27, 28 and 29, 1939. The program includes sessions of interest to many industries concerned with accident prevention and safety to their employees. The protection of vision and eye, industrial lighting, and a discussion of occupational diseases are on the program for Wednesday, March 29.

Luncheons and dinners of cooperating agencies are planned for every day and many exhibits will be on display throughout the Convention.

Missouri Association of Public Utilities Convention

THE thirty-third annual State convention of the Missouri Association of Public Utilities will be held April 12, 13 and 14 in Kansas City, Mo., at Hotel Muehlebach.

Among the speakers will be: C. W. Kellogg, New York City, President Edison Electric Institute; Thomas R. Weymouth, New York City, Chairman Natural Gas Section, American Gas Association; C. B. Huntress, New York City, Republic Coal & Coke Co.; Nathaniel Leverone, Chicago, Ill., Automatic Canteen Co.; Frank E. Fehlman, New York City, Advertising Counsel; Ralph W. Carney, Wichita, Kan.; Ben C. Adams, Kansas City, Mo., Gas Service Co.; and Mayor Bryce B. Smith, of Kansas City.

Subject Committee on Underground Methods and Accessories Meeting

A MEETING of this Subject Committee will be held at the Edgewater Beach Hotel in Chicago on May 2. This will be an all day meeting held the day preceding the meeting of the Transmission and Distribution Committee. During the forenoon session the Insulated Power Cable Engineers Association will present a Symposium on IPCEA Specifications and Standards for Cable. A thorough discussion of these specifications and standards by cable users is desired. The afternoon session will be devoted to a Round Table discussion on underground problems in general.

Public Utility Transportation Problems on Program of World Automotive Enginering Congress

ADVANCED engineering design problems of aircraft, automobiles, trucks, buses, railcars, the role of tractors in our national economy, operating problems of fleet owners, and exhaustive reports on fuels and lubricants developments will be covered by the coast-to-coast 1939 World Automotive Engineering Congress of the Society of Automotive Engineers.

The Congress opens May 22 in New York for a five-day session, will be in Indianapolis May 29 to 30, in Detroit May 31 to June 2, and closes with a three-day session in San Francisco, ending June 8. Nearly 60 papers will be presented on outstanding problems of automotive engineering developments during the Congress. Governments of 35 foreign countries, and more than thirty technical societies abroad have been invited to participate in the program.

S.A.E. activities to sponsor sessions during the five-day technical meeting in New York, May 22 to 26, are: aircraft; aircraft engine; fuels and lubricants; passenger car; passengar car body; transportation and maintenance; truck, bus and railcar; diesel engine; and tractor and industrial power equipment. Two of the three T & M sessions will be devoted to public utility problems.

During the final days of the Congress in San Francisco, June 6 to 8, technical sessions will be under the auspices of the S.A.E. aircraft, transportation and maintenance, fuels and lubricants, and diesel engine activities. A session at San Francisco will be held on public utility transportation subjects.

CONVENTIONS AND MEETINGS

MARCH

1-2 Pennsylvania Electric Association, Operations Section, Benjamin Franklin Hotel, Philadelphia, Pa.
13-14 Wisconsin Utilities Association, Technical and Commercial Divisions, Pfister Hotel, Milwaukee, Wis.
16-18 Northwest Electric Light and Power Association, Business Development Section, Benson Hotel, Portland, Ore.
20-24 Annual Sales Conference Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.
24 Annual Power Sales Conference Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.
30-31 Southeastern Electric Exchange, Ponce de Leon Hotel, St. Augustine, Fla.
30-31 Missouri Valley Electric Association, Rural Sales Conference, Kansas City, Mo.

APRIL

1 Southeastern Electric Exchange, Ponce de Leon Hotel, St. Augustine, Fla.
3-4 Oklahoma Utilities Association, Tulsa Hotel, Tulsa, Okla.
6-7 Missouri Valley Electric Association, Engineering Conference, Kansas City, Mo.
10-11 Arkansas Utilities Association, Hot Springs National Park, Ark.
12-14 Missouri Association of Public Utilities, Muehlebach Hotel, Kansas City, Mo.
14 Maryland Utilities Association, Lord Baltimore Hotel, Baltimore, Md.
20-21 American Gas Association, Accounting Conference, The Greenbrier, White Sulphur Springs, W. Va.
27-28 Missouri Valley Electric Association, Accounting Conference, Kansas City, Mo.

MAY

1-4 Engineering Committees, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.
2-4 Chamber of Commerce of the USA, Washington, D. C.
8-12 National Fire Protection Association, Chicago, Ill.
14-18 National Electrical Manufacturers Association, The Homestead, Hot Springs, Va.
17-19 Pacific Coast Electrical Association, Del Monte Hotel, Del Monte, Calif.
21-25 National Electrical Wholesalers Association, The Homestead, Hot Springs, Va.
22-25 National Association of Purchasing Agents, San Francisco, Calif.
26-30 Westinghouse Agent-Jobbers Association, The Homestead, Hot Springs, Va.

JUNE

6-8 EDISON ELECTRIC INSTITUTE, Waldorf-Astoria Hotel, New York, N. Y.
21-24 Canadian Electrical Association, Digby, N. S.
26-29 National Association of Cost Accountants, Atlantic City, N. J.
26-30 American Institute of Electrical Engineers, San Francisco, Calif.

OCTOBER

2-6 National Restaurant Association, Chicago, Ill.
Wk. Oct. 2nd—Third Annual Conference, Commercial Electric Cooking Council, Chicago, Ill. (*date to be announced*).
9-12 American Gas Association, New York City, N. Y.

Forthcoming Meeting of the High Tension Conference (C.I.G.R.E.)

THE Tenth Meeting of the C.I.G.R.E. (International High Tension Conference) will be held in Paris from Thursday, June 29, until Saturday, July 8, 1939. This will be a continuation of the nine former meetings, which have been held regularly every two years since 1921, and at which important problems of electrotechnical art come up for periodical discussion.

The 1939 meeting will deal, in particular, with the most recent progress in the construction and maintenances of apparatus used for generation, transformation and circuit rupture; the construction insulation and maintenance of overhead lines and underground cables; and the operation, protection and interconnection of networks.

One hundred and ten reports from 20 different countries from various parts of the world will be presented and discussed during the nine days of the Conference. The last meeting, which took place in 1937, was attended by 1,175 members, from 46 different countries, and included representatives of 27 governments and 8 international associations.

Membership of the Conference is open to electrical engineers from all over the world, whatever their specialty may be, and full benefit of the papers and discussions is available to any person speaking English, French, German, or Italian.

Full information on the Conference may be obtained from the President of the U.S.A. National Committee of C.I.G.R.E., Mr. Frederic Attwood, 50 Church Street, New York.